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Final Report

Incident Management

Prepared by

Cambridge Systematics, Inc.

in association with

JHK & Associates
Transmode Consultants, Inc.
Sydec, Inc.

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Acknowledgments

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Summary

Highway congestion is a daily phenomenon in all large metropolitan areas and a source of frustration and anxiety for millions of commuters and business travelers. Incidents – vehicle accidents and breakdowns that tie up highway traffic – are a major cause of urban highway congestion. It is estimated that incidents account for 60 percent of the vehicle-hours lost to congestion. Incidents cause billions of hours of lost time every year and impose huge economic costs on state and national economies.

Incidents are a special concern for motor carriers. Incident congestion has a direct impact on the productivity and profitability of the motor carrier industry, and truck-involved incidents exacerbate the public's negative image of trucking and truck safety.

Incident management programs are in place in many cities, but the scope of most incident management programs is limited. With few exceptions, incident management programs are not visible to the public, and the general public perception is that they are not doing the job.

This study looks at what is being done to deal with incident congestion and recommends actions to reduce the time lost to highway incidents. The primary focus of the study is on incident management, not incident prevention.

The study concludes that the major impediments to development of comprehensive metropolitan incident management programs are organizational and institutional. Incident management programs lack a clear mandate. Once a local problem, incident management has become a metropolitan-scale problem that falls awkwardly between the traditional responsibilities of state government and local government. Responsibility is divided among many agencies, each of which has a legitimate role in incident management, but all too often duties overlap, authority is fragmented, and actions are inconsistent.

The problem is compounded because the costs of incident congestion, and therefore the benefits to be gained by reducing incident delay, are not well understood. Most metropolitan areas lack reliable counts of incidents; adequate measures of traffic impacts; and consistent estimates of overall highway congestion.

The study finds that incident management programs can address the problem. The techniques, equipment, and expertise to operate effective

programs are available and proven. There are successful models for developing and operating comprehensive metropolitan incident management programs. Moreover, incident management can be cost-effective. The Chicago incident management program returns about $17 in benefits for each $1 invested in the program.

The key organizational approaches used by successful incident management programs include: traffic management teams; traffic operations centers; dedicated service patrols; incident command systems; contingency planning; quick-clearance policies; partnerships with commercial radio and television stations; and a strong service orientation.

The study recommends that states mandate the development of comprehensive metropolitan incident management programs; assign responsibility for implementation of these programs; and establish clear lines of authority for the management of incidents. In addition, the study recommends that states adopt quick-clearance policies and require uniform annual reporting of incidents.

The study recommends that the ATA strongly support federal and state incident management programs and quick-clearance policies. It also recommends that ATA develop an education program on incident management for state trucking associations and private fleet associations so that they can effectively explain and support industry policy on incident management before their state legislatures.

The study recommends that the next federal highway act make capital and operating funds available to states to set up or expand comprehensive incident management programs. Funding in the initial two years should be at a ratio of 95 percent federal funds to 5 percent state matching funds, stepping down to a 50:50 ratio in succeeding years. It recommends further that federal transportation policy explicitly recognize the role and importance of incident management, and traffic management generally, in reducing congestion. And finally, the study recommends that the Federal Highway Administration develop and demonstrate methodologies for the uniform measurement and reporting of recurring congestion, incidents, and the congestion impacts of incidents.

1. Introduction

Highway congestion is a daily phenomenon in all large metropolitan areas and a source of frustration and anxiety for millions of commuters and business travelers. Incidents – vehicle accidents and breakdowns that tie up highway traffic – are a major cause of urban highway congestion. This study looks at what is being done to deal with incident congestion and recommends actions to reduce the time lost to highway incidents. The primary focus of the study is on incident management, not incident prevention.

Congestion

Once a downtown issue, congestion is now a metropolitan concern. Congestion is a symptom of the travel boom that has occurred in our cities and metropolitan areas, and reflects underlying structural changes in population, employment, and automobile use, especially in the suburbs:[1]

- Metropolitan areas have grown rapidly. Over three-fourths of the U.S. population now lives in urban areas. Since 1970, most of the nation's growth in population and jobs has been in metropolitan areas; three-fourths of this growth has occurred in the suburbs.

- More people are working. Almost two-thirds of the adult population is working, and women now make up almost half of the nation's work force. In the 1970s employment grew about twice as fast as population,' the highest rate of expansion in any decade since the 1900s.

- More people have cars. The majority of households now have two or more cars. As a nation, we have more vehicles than licensed drivers.

- More people are commuting by car. Automobile trips now account for over four-fifths of all work trips. In some metropolitan areas, over half of all work trips are made from suburb-to-suburb.

The concentration of people and jobs, along with the increased use of automobiles for shopping and recreation, has fueled a steady growth in vehicle-miles of travel. Since 1970, travel in urban areas (predominantly passenger vehicle travel but including truck travel) has doubled and travel on urban interstates has tripled.[2]

The growth in travel has outpaced our investment in highways. Over the last twenty years, capital spending on roads and bridges has dropped precipitously, and maintenance expenditures have lagged subs tantially.[3] See Exhibit 1. State and local government investment has increased in recent years, but overall we are living with an aging road system not much larger than it was in 1970.

With limited growth in roadway capacity there has been an increase in congestion. In 1981, 16 percent of urban interstate miles were severely congested (that is, operating at levels of service D and E with volume-to-capacity ratios in excess of 0.95 during peak periods). In 1988 over 30 percent of urban interstate miles were severely congested.[4]

Demographic projections suggest that congestion will not ease appreciably in the foreseeable future:[5]

- Population growth is slowing but is still expected to grow by 30 million people over the next twenty years. This is equivalent to 70 percent of the population growth experienced over the last twenty years.

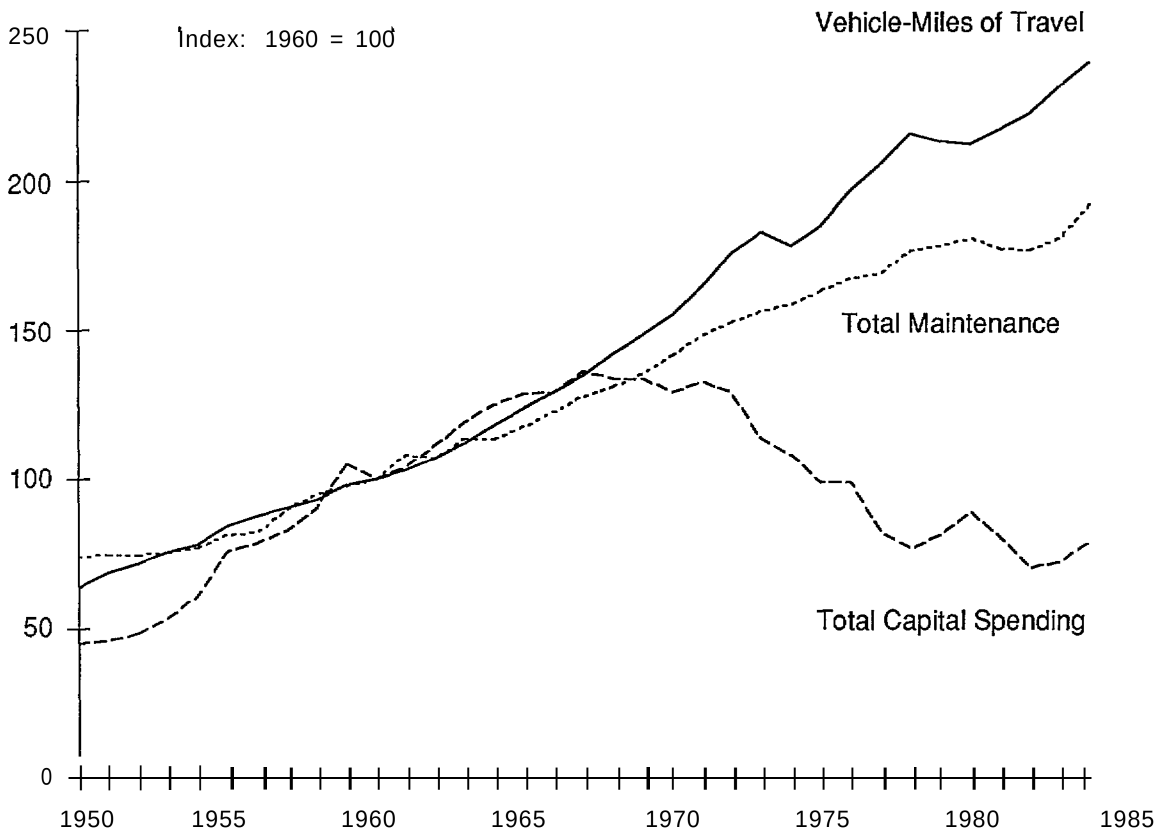
- Over 80 percent of the nation's growth is expected to be in metropolitan areas and most of it will occur in the suburbs.

- For the next twenty years the baby-boom generation will be middle-aged, providing a source of economic growth and travel demand.

Congestion is a national issue today because it is affecting trucking and the manufacturing and retailing sectors that trucking serves. Congestion is no longer limited to highways near downtowns; it has spread over the beltways that were once the bypass routes for congested cities. And it is no longer a peak-hour problem; it has become a peak-period problem, spreading over four, six, and even eight hours a day in the larger metropolitan areas. Metropolitan congestion is creating sticky nodes on the national highway system, and it is impeding the flow of regional and interstate freight as well as local freight.

Metropolitan congestion has a significant impact on trucking. One-third of all truck-miles of travel occur in large urban areas, and it is estimated that two-thirds of that mileage is on freeways.[6] Driving on congested freeways increases driving time, fuel consumption, and wear-and-tear on trucks. These additional costs are ultimately passed on to shippers and receivers, increasing the cost of transporting goods. The impact is sizeable because the economy is very dependent upon trucking. In 1988 trucks carried 40 percent of all domestic tonnage and accounted for 78 percent of domestic freight revenues, about $240 billion dollars.[7]

Exhibit 1. Vehicle-Miles of Travel, Total Capital and Maintenance Spending for Highways, Streets, Roads and Bridges



Source: Apogee Research, Inc., from FHWA data.

The effect of congestion on freight movement is more noticeable as global competition forces U.S. companies to change the way they do business. Many of the changes – such as the use of overseas parts suppliers, introduction of just-in-time manufacturing and distribution, and increased emphasis on quality and customer service – are having a direct impact on motor carriers. Carriers are being asked to provide faster, more reliable, and more cost-effective services; but increasing congestion on the national highway network is making it costly to meet these service and productivity requirements.

Forecasts of economic activity suggest that we will be even more dependent on fast, reliable, and cost-effective freight services in the future than we are today:’

- Most of the nation's growth will be in services, high-technology industries, and foreign trade. Firms in these growth sectors will be smaller, employ fewer people, and be less materials intensive. There will be less bulk freight, more small shipments, and more demand for individualized freight services.

- The value of shipments will increase. The need for rapid, on-time delivery of these products will increase the demand for air and truck transportation.

- Production will be geographically dispersed. There will be fewer large facilities and more small facilities. The need for low-cost land and access to labor will continue to make suburbs attractive to growing industries.

Congestion is recognized as a problem. The U.S. Department of Transportation, in its recently issued "Statement of National Transportation Policy," emphasizes the need to "maintain and expand the nation's transportation system" with particular commitment "to reducing congestion in the aviation and highway systems."’ The Transportation 2020 Program identified congestion and the inability to deal with it effectively as the major concern of urban transportation users.[10] And Mobility 2000 has identified increasing congestion as the primary reason that the nation should invest heavily in intelligent vehicle/highway systems.[11]

But there is limited information on the scope and cost of congestion. The only comprehensive national estimate of the cost of urban freeway congestion was made in a staff study by the Federal Highway Administration.[12] Using FHWA's Highway Performance Monitoring System database, it was estimated that freeway congestion in the nation's thirty-seven largest cities cost the nation 1.25 billion vehicle-hours of lost time in 1984. The lost time and wasted fuel were valued at $9 billion. In a 1987 update, the cost of congestion was estimated at 2 billion hours and $16 billion. Using the 1987 statistics and current trends, it was projected that urban congestion costs could rise as high as 8 billion vehicle-hours and $88 billion by 2005.

Most of the cost of congestion is borne by large cities. A dozen large urban areas account for over 80 percent of freeway congestion cost. New York, Los Angeles, San Francisco, and Houston have the highest congestion costs, about $2 billion per year each in current dollars; Detroit, Chicago, Boston, Dallas, and Seattle, about $1 billion each; and Atlanta, Washington DC, and Minneapolis, about $0.5 billion each.

The patterns of past growth and the trends for the immediate future all point toward the conclusion that congestion will continue to be a significant metropolitan and national issue. Without attention, congestion will sap the productivity and competitiveness of our economy, contribute to air pollution, and degrade the quality of life in our metropolitan areas.

Incidents

Incidents are a major cause of congestion. Congestion has two components: recurring congestion – the predictable delay caused by the high volume of vehicles using the highways; and non-recurring or incident congestion – the unpredictable delay caused by incidents. Incidents include accidents and a vast array of small events – stalls, flats, spills, debris on the road, even highway maintenance work – that divert drivers' attention and disrupt the normal flow of traffic.

It is estimated that incidents account for 60 percent of the vehicle-hours lost to congestion. According to the FHWA estimates for 1987, incident congestion cost the nation 1.3 billion vehicle-hours of delay at a loss of nearly $10 billion. For a large metropolitan area like New York, incident congestion today costs over $1.2 billion per year or about $100 per person per year.

Incidents are a special concern for motor carriers. Incident congestion has a direct impact on the productivity and profitability of the motor carrier industry, and truck-involved incidents exacerbate the public's negative image of trucking and truck safety. Media coverage of truck fires in Washington DC, San Francisco, and Los Angeles has reinforced the public's perception that truck incidents are more frequent today; are more severe; and are responsible for a growing amount of the frustrating congestion on urban freeways. The public response has been to call for truck bans and broad restrictions on the transportation of hazardous materials, actions that could substantially increase the cost of goods and services to consumers.

Incident management programs are in place in many cities. Exemplary programs were established in Chicago in the 1960s and in Los Angeles in the 1970s. The techniques of incident management are well developed and well documented: Engineers for Detroit's Lodge Freeway published detailed studies of incident rates in the early 1960s. Caltrans reported extensively in the mid-1970s on the techniques developed during the Los Angeles Area Freeway Surveillance and Control Project. FHWA published two voluminous reports on freeway and incident management – "Alternative Surveillance Concepts and Methods for Freeway Incident Management" in 1978 and "A Freeway Management Handbook" in 1983. And in 1988 the Transportation Research Board sponsored a synthesis report on "Freeway Incident Management."

But the scope of most incident management programs is limited. The majority are focused on specific facilities – tunnels and bridges. Of the twelve major cities Listed above, only four or five can be said to have comprehensive metropolitan incident management programs, and the resources allocated to the programs have not kept pace with congestion. With few exceptions, incident management programs are not visible to the public, and the general public perception is that they are not doing the job.

The questions addressed in this study are: What are the barriers to better incident management? What can and should be done to improve incident management?

2. Incident Management

Types of Incidents and Their Impact

It is estimated that 70 percent of all highway incidents are recorded by police and highway agencies, usually as brief annotations in communications logs. The other 30 percent go unreported and, as such, are assumed to be minor incidents having little impact on traffic.[1] Exhibit 2 is a composite profile of recorded incidents drawn from the limited research available on freeway incidents.

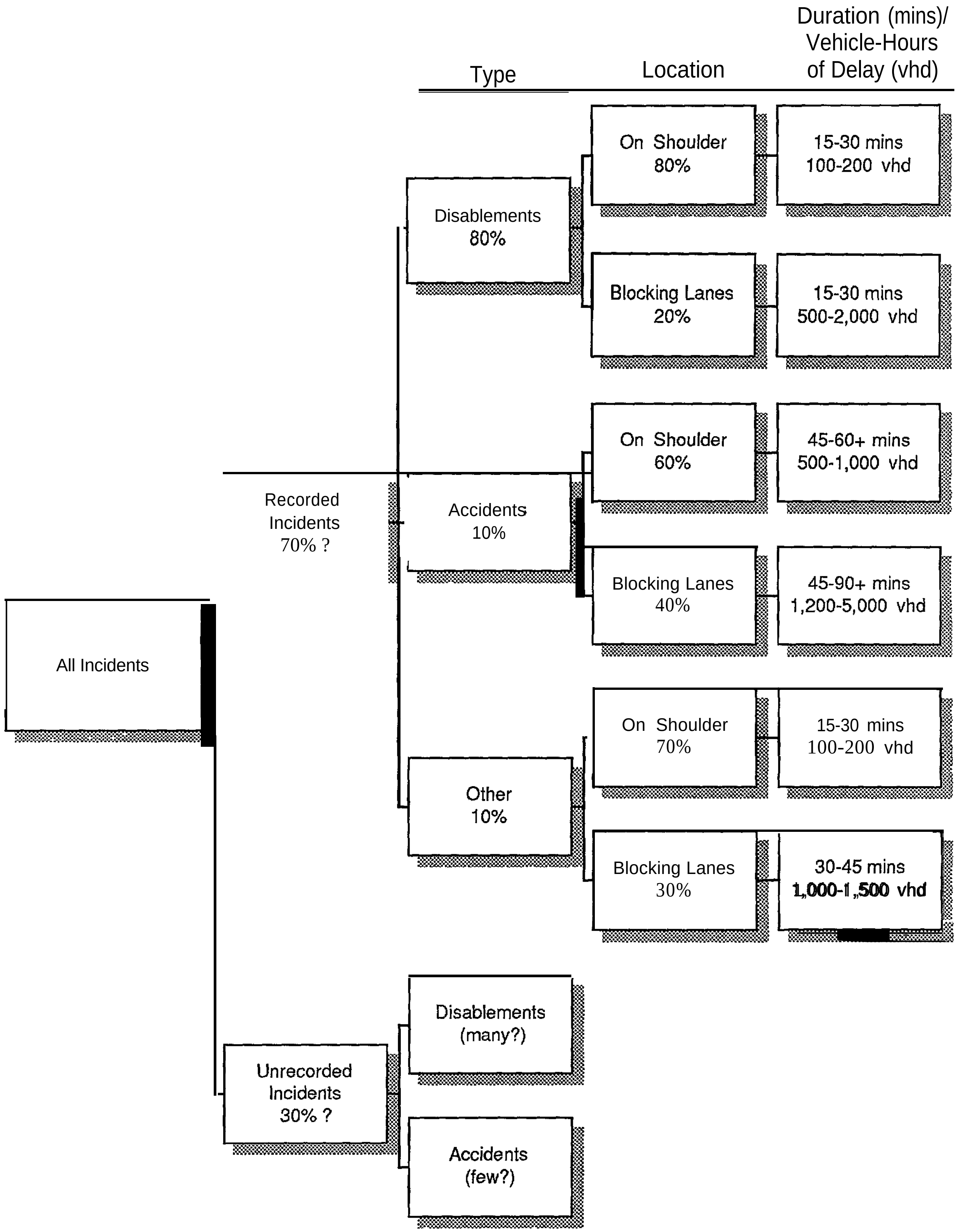
Of the incidents that are recorded by police and highway departments, the vast majority, some 80 percent, are vehicle disablements – cars and trucks that have run out of gas, had a flat tire, or been abandoned by their drivers.* Of these, 80 percent wind up on the shoulder of the highway for an average of 15 to 30 minutes. During off-peak periods when traffic volumes are low these disabled vehicles have little or no impact on traffic flow. But when traffic volumes are high the presence of a stalled car or a driver changing a flat tire in the breakdown lane can slow traffic in the adjacent travel lane, causing 100-200 vehicle-hours of delay to other motorists.[3]

Twenty percent of disabled vehicles fail in the travel lanes, blocking one or more lanes of traffic. Most disabled vehicles are moved to the shoulder within 5-10 minutes, but larger vehicles, such as stalled trucks, are often difficult to move and block travel lanes for a longer period of time. On average, vehicles that break down in the travel lanes are there for 15-30 minutes, and during peak periods they cause 500-2,000 vehicle-hours of delay for the traffic that must squeeze around them.

Accidents account for only 10 percent of reported incidents. Most are the result of minor collisions, such as sideswipes and slow-speed rear-end collisions. In 60 percent of accidents, drivers are able to move their vehicles to the shoulder. Each such incident lasts an average of 45-60 minutes. In congested traffic, they can trigger 500-1,000 vehicle-hours of delay per incident. The congestion impact of those minor accidents is substantial because the presence of a police car, tow truck, ambulance, or fire truck will cause passing motorists to slow down and gawk, even if the vehicles involved in the accident are well off the highway.

Forty percent of accidents block one or, occasionally, two lanes of traffic. These often involve injuries or spills. Each such incident typically last 45-90 minutes causing 1,200-2,500 vehicle-hours of delay.

Exhibit 2. Composite Profile of Reported Incidents by Type



Source: Cambridge Systematics, Inc.

It is estimated that major accidents make up 5-15 percent of all accidents and cause 2,500-5,000 vehicle-hours of delay per incident.[4] A very few of these major incidents, typically those involving hazardous materials, last ten to twelve hours and cause 30,000-40,000 vehicle hours of delay. These incidents are rare, but their impacts can be catastrophic and trigger gridlock.

Emergency maintenance work, debris on the road, brush fires, wandering pedestrians, stray animals, and other events account for the remaining 10 percent of incidents that appear in police and highway agency records. Their impacts are similar to those caused by vehicle disablements. Seventy percent are confined to the shoulder where they have minimal impact on traffic; and 30 percent block one or more lanes of traffic for 30-45 minutes causing 1,000 1,500 vehicle hours of delay per incident under congested conditions. Highway construction is classified as a type of incident in traffic engineering and incident management literature, but construction “incidents” are not usually reported by police and highway agencies.

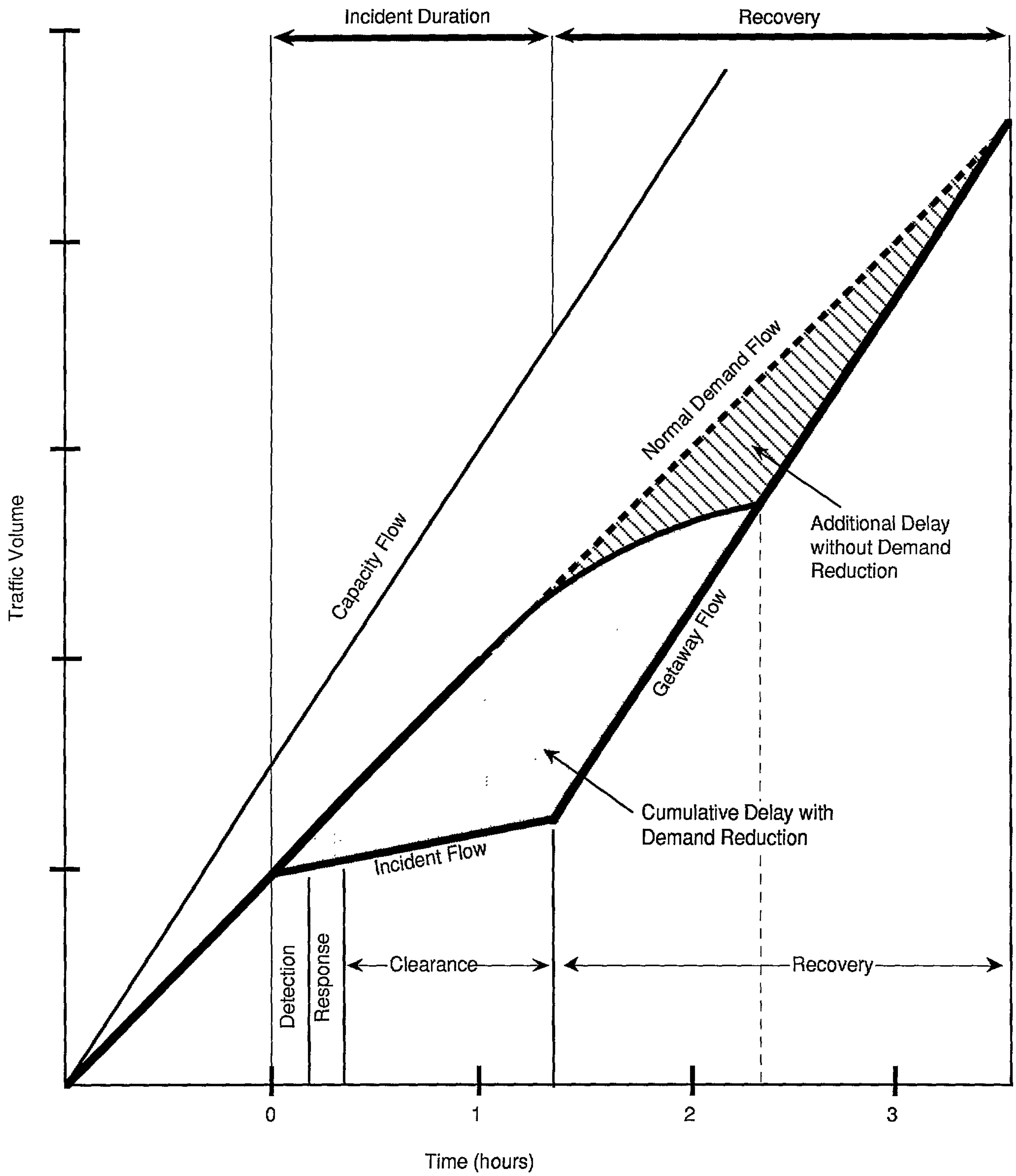
Traffic Flow During Incidents

Incidents create bottlenecks on the highway, slowing and often stopping the flow of vehicles. The congestion caused by an incident depends on the duration of the incident, the number of lanes that are closed, and the volume of traffic at the time. The dynamics of an incident are illustrated in Exhibit 3.[5]

When an incident blocks a lane of traffic it chokes down the flow of traffic, and a queue of traffic builds upstream of the incident. Blocking one out of three lanes can cut traffic flow by fifty percent; blocking two out of three lanes can cut traffic flow by eighty percent.[6] The queue and the vehicle-hours of delay will continue to build until the incident is cleared and traffic flow is restored. The vehicle-hours of delay that accrue to motorists in the queue are represented in the exhibit by the shaded area that lies between the normal flow rate and the lower incident flow rate. If the normal flow of traffic into the incident site is reduced by diverting traffic to alternate routes, then the vehicle-hours of delay are minimized (shaded area). If normal traffic flow is not diverted, then additional vehicle-hours of delay (hatched area) are accrued.

Once the incident is cleared, traffic will flood through the incident site until the queue is dissipated, but the getaway flow is limited by the maximum capacity of the highway. On a congested urban freeway, an incident can dam up a huge reservoir of vehicles, and it may take an hour or more after the incident is cleared to dissipate the accumulated traffic.

Exhibit 3. Schematic of Traffic Flow During an Incident



Source: Cambridge Systematics

Incident Management

Incident congestion can be minimized by clearing incidents as quickly as possible and diverting traffic before vehicles are caught in the incident queue. About thirty cities have programs to manage freeway incidents and reduce incident congestion. Exhibit 4 lists the major freeway management programs in the US. and the techniques they employ for incident management.[7] The scope and effectiveness of these programs varies widely.

The time saved by an incident management program depends on how well the four stages of an incident – detection, response, clearance, and recovery – are managed.' The general state-of-practice is as follows:

- **Detection.** Most major incidents are detected within 5-15 minutes; however, minor incidents may go unreported for 30 minutes or more. It is estimated that one-third to one-half of reported incidents are detected by routine police patrols or, in the few cities that have them, by service patrols. The other half are reported to police from roadside callboxes, over citizen-band radio, and increasingly by mobile phones. A significant accident may trigger up to a dozen calls to the police. Automatic vehicle detectors, usually wire-loop detectors installed in the pavement, are used in about a half-dozen cities to monitor traffic flow. With proper computer software, these can be used to detect the traffic impacts of major incidents and some minor incidents. Bridges, tunnels, and a few highly congested highway corridors are monitored using closed-circuit television cameras. These are particularly useful for verifying incidents.

- **Response.** The police handle most incidents. It is their responsibility to confirm the incident; assess what needs to be done; and summon help as needed. Communications about an incident are commonly handled directly by police dispatchers, but an increasing number of cities and states are building special-purpose traffic management centers to coordinate traffic and incident communications. State police or state highway patrols have jurisdiction over most freeways including urban freeways, but in some states, such as Texas, freeways within city limits are under the jurisdiction of city police. Almost all urban areas have emergency response plans for catastrophic incidents, especially those involving hazardous materials; some have traffic diversion plans for major incidents; and a few have procedures for routine incidents. Traffic management teams representing state and local police and highway

Exhibit 4. Incident Management Programs

SYSTEM TYPE AND LOCATION	DETECTION & VERIFICATION: Traffic Operations Center	Service Patrols	Electronic Surveillance	Closed-Circuit TV	Citizen Call	Call Boxes	Other	RESPONSE: Incident Mgt. Teams	Wrecker Agreements	Agency Equipment	Other	MOTORIST INFO: Alternate Routes	Highway Advisory Radio	Media Partnership	Variable Message Signs	GENERAL COMMENTS
EXISTING AREAWIDE SYSTEMS																
Anaheim, CA	●			●		●		●			●	○	○	○	●	Integrated freeway/arterial system
Baltimore, MD	●	●					●	●	●	●	●	●	●	●	●	Initial phase of statewide CHART Program
Chicago, IL	●	●		●	●		●	●		●	●		●	●	●	Illinois DOT operating since 1960
Detroit, MI	●		●	●	●	●			●						●	Major expansion underway
Fort Worth, TX	●	●	○	○				●	●		○	○	○	●	●	20-year project; over 260 miles of freeway
Houston, TX	○	●	●	●		○	○	●	●		●	○		○	●	20-year project; over 555 miles of freeway
Los Angeles, CA	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	System expansion and upgrade underway
Minneapolis/St. Paul	●	●	●	●	●	●	●	●	●		●		●	●	●	Major expansion underway
New York/New Jersey (TRANSCOM)	●						○	●			●	●	○	●		Regional information/response coordination
Phoenix, AZ	○		○	○	○			●	●			○			○	Twenty-year plan; over 200 miles of freeway
Richmond, VA	○	●						●	●			●		●	○	Initial phase of long-term program
San Antonio, TX	○	●	○	○				●	●						○	Ten-year plan developed
San Diego, CA	●		●	●		○		●	●				○	●	●	Major expansion underway
Seattle, WA	●		●	●				●	●	●	●	○	●	●	●	Major expansion underway; FAME Program
Washington, DC/Fairfax Co., VA	●				●		●	●	●			○		●		Non-freeway, county police program
Washington, DC/Maryland Suburbs	●	●			●		●	●	●	●	●	●	●	●	●	Initial phase of statewide CHART Program
Washington, DC/Northern VA Suburbs	●	●	●	●	●	●	●	●	●			●		●	●	Major expansion underway

● In Place
○ Planned or Proposed

Source: FHWA

Exhibit 4. Incident Management Programs

SYSTEM TYPE AND LOCATION	DETECTION & VERIFICATION							RESPONSE				MOTORIST INFO				GENERAL COMMENTS
	Traffic Operations Center	Service Patrols	Electronic Surveillance	Closed-Circuit TV	Citizen Call	Call Boxes	Other	Incident Mgt. Teams	Wrecker Agreements	Agency Equipment	Other	Alternate Routes	Highway Advisory Radio	Media Partnership	Variable Message Signs	
NEW AREAWIDE SYSTEMS																
Atlanta, GA																Initial scoping phase/Atl. Reg. Comm. (COG)
Austin, TX																Initial scoping phase/SDH&PT
Cincinnati, OH	○		○	○	○			○					○	○	○	Feasibility study complete; PE initial planning
Columbus, OH	○	●	○	●			●	●		●	●			○	○	Ten-year plan underdevelopment
Connecticut Freeways		●											●		●	Feasibility studies done for I-95, I-91 & I-84
Dallas, TX	○	●	○	○				●							○	Ten-year plan under development/SDH&PT
El Paso, TX	○		○	○				●							○	Ten-year plan under development/SDH&PT
Fresno, CA	○							○							○	Initial scoping phase/Caltrans District 6
Jacksonville, FL								●								Freeway management team
Kansas City, MO																Initial scoping phase/MO Hwy. & Trans. Dept.
Massachusetts Fwys	○											○				All I-freeways; tied to hazmat evac. planning
Miami, FL	○	○	○					●	○			○		○	○	Feasibility study complete
Michigan Freeways					●			○				○				Plan under development; all I-freeways
Milwaukee, WI	○	○	○	○	○			○	○			○		○	○	Area study complete; impl. plan under devel.
Montgomery County, MD	●			○	○		○	●			●	●		●		County traffic engineering department
Orange County, CA	○	●	●	○		●		●					●		●	Long-term plan under development
Orlando, FL	○	○	○	○	○		○	●	●		○	○		○	○	Includes TRAVTEK-IVHS Demo. Project
Portland, OR	○		○	○	○	○		○				○		○	○	Six-year plan developed
Sacramento, CA	●					○		●					●		●	Initial scoping phase/Caltrans District 3
Saint Louis, MO																Initial scoping phase/MO Hwy. & Trans. Dept.
San Bernadino County, CA	○							●					●		●	Initial scoping phase/Caltrans District 8
San Francisco, CA	○	●	○	○	○	●			●					○	○	Twenty-year plan developed for 500 mi system
Spokane, WA																Initial scoping phase/Wash SDOT
Tacoma, WA																Initial scoping phase/Wash SDOT
Tampa Bay/St. Petersburg, FL																Two freeway management teams
Tidewater Area, VA	○	●	○	○	○			●	●			●	●	●	●	Tied w/exist. br/tunnel systems, new HOV
Westchester County, NY	○	●		○	○		○	○	●			●	○	○	○	Joint county and state effort

Exhibit 4. Incident Management Programs

SYSTEM TYPE AND LOCATION	DETECTION & VERIFICATION							RESPONSE				MOTORIST INFO				GENERAL COMMENTS
	Traffic Operations Center	Service Patrols	Electronic Surveillance	Closed-Circuit TV	Citizen Call	Call Boxes	Other	Incident Mgt. Teams	Wrecker Agreements	Agency Equipment	Other	Alternate Routes	Highway Advisory Radio	Media Partnership	Variable Message Signs	
CORRIDOR SYSTEMS																
CA I-10/Los Angeles	●	●	●	●	○	●	○	●	○	●	○	●	●	●	●	"Smart" Corridor Demonstration Project
DE Interstates						●										Callboxes
FL I-95/Ft. Lauderdale		●						●								Construction-oriented; frwy mgt team
FL Rural Interstates						●										Callboxes
IN I-80 (northwest)	○		○	○				○						○	○	Borman Xwy; plan under development
MD US40 (west)	●							●	●	●	●	●	●		●	Initial phase of CHART Program
MD US50	●	●			●		●	●	●	●	●	●	●	●	●	"Reach-the-Beach" Program
MI I-75					●			●				●				Non-urban I (DOT/State Police, Distict 6)
NJ Turnpike	●	●	●	○				●	●	●	●	●		●	●	Expansion/upgrade of system underway
NY Long Island Expy	●	●	●	○	●			●	●	●	●	●		●	●	INFORM -- 30 mi by 5 mi corridor
NY State Thruway	●	●		○	●			●	●	●		○	●	●	●	Plan under development for 599 miles
OH I-75/Dayton												●		●		City Police/Traffic
PA I-376/Pittsburgh	○	○	○	○			○	○							○	PennDOT has completed study
PA Turnpike						○										Callboxes planned, tunnel systems
RI I-95						●		●				●			●	Private/public team
TX I-10/El Paso			○	○				●	●	●	●	●			●	Construction oriented; will be permanent
TX I-75/Dallas	○	○		○			○	○					○	○	○	Construction oriented; will be permanent

Exhibit 4. Incident Management Programs

SYSTEM TYPE AND LOCATION	DETECTION & VERIFICATION							RESPONSE				MOTORIST INFO				GENERAL COMMENTS
	Traffic Operations Center	Service Patrols	Electronic Surveillance	Closed-Circuit TV	Citizen Call	Call Boxes	Other	Incident Mgt. Teams	Wrecker Agreements	Agency Equipment	Other	Alternate Routes	Highway Advisory Radio	Media Partnership	Variable Message Signs	
BRIDGES, TUNNELS, AND SPOT LOCATIONS																
Baltimore, MD Tunnels	●		●	●			●		●	●		●	●	●	●	Maryland Transportation Authority
Buckman Br, I-295, Jacksonville, FL		●						●	●	●						Florida DOT
East St. Louis Bridge, IDOT		●			●	●				●			●	●		Mississippi River bridges
Eisenhower Tunnel, I-70, Colorado	●		●	●						●		●			●	Colorado Department of Highways
Eliz. River Tunnels, Norfolk/Ports, VA	○	●	○	○	●	●	●			●				●	○	
Escambia Bay Brs (2), FL, I-10/US98	●					●		●	●						●	
Hampton Rd Br/I-64 and Tunnel, VA	●	●	●	●	●		●	●		●	●		●	●	●	
Howard Franklin Br., Tampa, FL	●	●	●	●		●		●	●			●		●	●	
James R. Br., Newport News, VA	●	●		●	●	●				●	●		●			4 mi. of 4-lane divided; no shldrs; ADT23,000
Lehigh Tunnel, PA Turnpike	●	●					●			●					●	
Lincoln and Holland Tunnels, NY/NJ	●	●	●	●			●		●	●	●	●	●	●	●	Port Authority of NY & NJ
Mobile, AL I-10/US98	●			●												
Oakland Bay Br, SF	●	●	●	●		●	●	●		●	●			●	●	
Sunshine Skyway, FL (Tampa)	●			●		●		●	●			●		●	●	
Tappan Zee Bridge, NY/NJ(4)	●	●		○	●			●		●		●		●	●	3 mi. long across Hudson River
TBTA, NY (4 bridges)	●		○	●		●				●				●	●	7 bridges, 2 tunnels

engineers are gaining in popularity as a way to develop response plans and traffic diversion routes.

- Clearance. Private tow-truck operators clear the great majority of freeway incidents. Most police departments maintain formal or informal rotation lists that distribute work among competing tow operators, and some let work on the basis of competitively bid franchises. Very few police or highway agencies have performance standards for private tow operators, and incompetent operators are seldom dismissed except for gross negligence. The exceptions to this pattern are bridge and tunnel operating authorities, which are likely to own and operate their own tow trucks and wreckers.

  An effective clearance operation requires that the police officer on the scene diagnose the problem correctly; summon the right tow equipment; and make sure the operation is carried out with dispatch. This is seldom a problem in minor incidents, such as stalls and fender-benders, but is frequently a problem in major incidents, especially those involving large trucks. Minor incidents are frequent, and police officers quickly develop the experience to deal with them. Large-truck incidents are much less frequent, and few police officers develop adequate experience unless they are assigned to special commercial-vehicle safety enforcement units or receive training in truck-clearance techniques. These techniques vary with the type of load, configuration of the truck, and potential environmental impacts. Most police departments do not provide specialized training in incident management; tow-truck rotation lists often turn out the wrong type of equipment; and most private tow operators lack the expertise and experience to handle large truck accidents. These problems, often compounding, can double or triple the time required to clear an incident.

- Recovery. Recovery consists of three steps: restoring traffic flow at the site of the incident; preventing more traffic from flowing into the area and getting trapped in the upstream queue; and preventing congestion from spilling across the metropolitan traffic network. Incident congestion can be minimized by these actions, but traffic management is the least developed element of most incident management programs. Police at the scene of an incident have little time to manage traffic flow around an incident; indeed, many police and fire departments encourage their officers to block traffic as a safety measure to prevent their being run down by drunken or unobservant drivers. Corridor- and system-level traffic management is a goal of many incident management programs but is not often realized in practice.

In summary, the vast majority of incidents are vehicle disablements and minor accidents. During off-peak periods when traffic volumes are low, these incidents have little or no impact on freeway traffic. But when traffic volumes are high, their cumulative effect is substantial. Police and **private tow** operators can clear these incidents rapidly and efficiently, but most agencies do not give this work high priority. Incident congestion could be reduced considerably by assigning higher priority to the detection and clearance of minor incidents.

Major incidents are relatively few. They are given immediate attention, which is appropriate, but police officers and tow operators usually lack the training and experience necessary to handle these incidents efficiently. In major incidents, congestion could be reduced considerably by improving clearance and recovery capabilities.

3. Case Studies

Introduction

Five comprehensive metropolitan incident management programs were examined in detail. This chapter reports the findings of those case studies. The programs are representative of incident management in the United States, but they are not typical. These are exemplary programs that have been recognized for their effective and innovative efforts. The purpose of the case studies was to identify the technical, organizational, and institutional approaches that made these incident management programs successful. The case studies include established programs, emerging programs, and new approaches to metropolitan incident management:

Established Programs: Chicago and Los Angeles

The incident management programs in Chicago and Los Angeles are established programs. The Chicago program started in the early 1960s and the Los Angeles program took shape during the early 1970s. The key questions for these case studies were: What was achieved? Are the programs cost effective? How well have the organizations been able to adapt over time to the changing traffic and political environments?

Emerging Programs: Fort Worth and Minneapolis

Fort Worth and Minneapolis are relatively new programs. The two programs were selected because they are representative of a class of new and innovative traffic and incident management programs being developed in several states, including Maryland, Virginia, Arizona, Washington State, and Florida. The key questions for these case studies were: How do these programs differ from Chicago and Los Angeles? How are they deploying new traffic and incident management technology? How are they organizing their programs?

New Approaches: New York/New Jersey

TRANSCOM (the Transportation Operations Coordinating Committee) was selected because it is a departure from traditional incident management programs. It has forged a regional traffic and incident management capability in the New York / New Jersey metropolitan area by providing information about incidents and road construction to police and highway agencies across the region. The key questions for this case study were: How does TRANSCOM maintain a constituency for its services? How effective is information management as a traffic and incident management tool?

The case studies were done between January and April of 1990. Interviews were conducted in each city. Those interviewed included:

- State Police
- State Departments of Transportation
- City Police
- City Departments of Transportation
- Incident Management Program Managers
- Bridge and Tunnel Program Managers
- State Trucking Associations
- Motor Carriers
- Traffic Reporters
- American Automobile Association Clubs
- Private Sector Interest Groups
- Regional Planning Agencies
- Transportation Researchers
- FHWA Officials

Chicago

Evolution of the Program

Chicago's incident management program started in 1960 with a crisis on the newly opened Kennedy Expressway. Designed to handle 1,500 vehicles per hour per lane, the new highway was quickly swamped as peak-hour traffic volumes exceeded 2,000 vehicles per hour per lane. Stalled cars and fender benders aggravated congestion and often created massive traffic jams in those sections of the expressway that had no breakdown lanes. To manage the crisis, the Illinois Department of Transportation (then the Department of Public Works and Buildings) assigned twenty people in pick-up trucks to the job of patrolling the expressway during the morning and afternoon peak commuter periods. The emergency patrol, eventually named the "Minuteman Patrol," was charged with keeping the Kennedy Expressway open by clearing travel lanes of disabled vehicles.

Today, the program employs sixty people and has an annual operating budget of $3.5 million funded from state motor fuel taxes. The Minutemen operate in three shifts, twenty-four hours a day, on patrols that cover 80 miles of the 150-mile Chicago expressway system. The pick-up trucks have been replaced by a fleet of thirty-five heavy-duty tow trucks. Several large recovery trucks, cranes, and other specialized equipment have been added to the fleet. However, the basic function of the patrols has not changed: it is to ensure that the expressway system is working smoothly by clearing incidents from travel lanes as quickly as possible.

Building and Maintaining a Constituency

The Minuteman Patrol program has survived and grown because it has built a public constituency for itself by providing assistance to motorists. When a car breaks down on the Chicago expressways, the patrol will move it to a safe place (a "safe drop"); provide the driver with gas and water; help make minor repairs; and if necessary arrange for a commercial tow. A motorist in trouble can usually get assistance in less than half an hour. The patrol is funded out of state motor fuel tax revenues, and services to motorists are free. If the patrol provides gas, motorists are given an invoice for five dollars. Payment is voluntary and is made by mail to the state treasury, not to the Minutemen. The highly visible presence of the service patrol (the trucks are painted bright yellow) and their focus on personal service has built strong support and a positive reputation for the Minutemen. Public support for the program is now so strong that a commonly heard comment in Chicago is: "The Minutemen make Illinois DOT look good." To protect this reputation, the program manages its operations very tightly: vehicles are clearly marked with signs stating that the services provided to motorists are free; and personnel assignments are rotated to avoid charges of favoritism.

But maintaining the program has been a struggle. Illinois DOT has never had a formal mandate for the Chicago program. The program was initiated within the traffic group in the Chicago district and has always been closely identified with Chicago; there is no counterpart for the incident management group at Illinois DOT's Springfield headquarters. The only comparable program in Illinois is a much smaller program that manages the bridge crossing the Mississippi River from East Saint Louis.

The program grew steadily throughout the 1960s as new expressways were added to the Chicago system. By the end of the decade, the Minuteman Patrol employed over 120 people and operated a fleet of over fifty tow trucks. The staff level was cut in half in the early 1970s during a change in the state's administration and has continued to fluctuate with the vicissitudes of state politics: expanding under state DOT administrators from the Chicago area and contracting under administrators from downstate Illinois.

Illinois DOT has used reconstruction programs to maintain and revitalize the emergency patrol program. Federal and state construction guidelines permit Illinois DOT to charge the cost of traffic and incident management around worksites to construction budgets. When the Dan Ryan Expressway was to be rebuilt in 1988, Illinois DOT formed a committee to develop plans to handle traffic and incidents during the reconstruction. As a major participant in the project, the Minuteman Patrol was able to add sixteen more people and invest in used military trucks and cranes to increase their recovery equipment. After the Ryan rebuild was complete, the program was able to obtain additional state funding and retain thirteen of the sixteen temporary people as permanent patrolmen. Illinois DOT hopes to use the next project – reconstruction of the Kennedy Expressway where the program started thirty years ago – as another opportunity to demonstrate the value of expanding the program.

Experience More Valuable Than Equipment

Although Illinois DOT takes great pride in the tow trucks and other equipment that it has assembled for its incident management program, it believes that the critical factor in its success is the level of experience among the Minuteman personnel. Program managers spend considerable time screening and training applicants for the patrol jobs; much of the effort is directed toward finding people who can work effectively in teams. Once in the program, Minutemen tend to stay; over fifty percent of the current staff has been with the program for more than ten years. With this continuity, the patrol has been able to develop considerable expertise and sophistication in righting and towing heavy trucks as well as in dealing with people.

The cost of obtaining the experience to operate an effective freeway program can be quite high, as the Illinois State Police found out when they took over enforcement responsibilities from the Chicago City Police. During the 1960s and 1970s the Chicago Police Department's metropolitan traffic unit enforced traffic laws on the expressway system. Like the Minuteman Patrol, they had built up a cadre of experienced officers over a period of twenty years. But by the early 1980s, Chicago was short of money and could no longer afford the expressway traffic group. In 1984, citing budget cuts, pressures to focus on neighborhood crime, and concerns about managing private tow operators, the Chicago Police withdrew from the expressways and the Illinois State Police assumed the responsibility for enforcement.

The state police began their operations with volunteers, many from rural downstate Illinois. Most had neither training nor experience in dealing with urban drivers on congested expressways. The state police lost a number of cruisers in accidents during the first year and took considerable criticism for closing down the expressways to investigate accidents. Their early efforts to build an experienced cadre of troopers were undercut by rotation policies and high turnover rates among rookies disillusioned with urban service. Since then, the state police have expanded their training programs to cover expressway traffic management techniques and have drawn upon the Minutemen for training in incident management and clearance. Although still understaffed, the state police have succeeded in developing a stable and sophisticated expressway enforcement operation.

The shift of enforcement responsibility from the Chicago police to the state police also meant that the Minutemen had to rebuild their institutional relationships. Although there were no formal interagency agreements established to ensure cooperation between the agencies, the Minutemen and the Chicago police had developed an effective working relationship, largely because the Minutemen were perceived by the Chicago police as supporting the traditional role and responsibilities of the police. When the enforcement jurisdiction changed, the Minuteman operation had to rebuild that relationship with the state police.

The process has been slow because each agency sets different priorities. The Minutemen judge their performance on how smoothly they keep the expressway working; the state police, on the other hand, are trained to protect individual and property rights and usually do not give traffic management a high priority. The police and the patrol are gradually building a new system of working priorities that satisfy the requirements of both agencies. The state police are acknowledging that to get their job done they need the Minuteman Patrol on the expressway system; and Illinois DOT has drawn the police into traffic management through a "hire back" program that permits Illinois DOT to pay off-duty troopers to manage the traffic details protecting Illinois DOT's construction work sites.

Organization

The state police are still grappling with the issue of how to best organize their expressway operations. The troopers patrolling the Chicago region currently operate out of four districts, each of which has its own command and communications center: District 3 in Chicago, District 4 in Crestwood, and District 2 in Elgin cover the Illinois DOT metropolitan Chicago expressway system. District 15 in Oakbrook polices the TriState Tollway (the region's north-south suburban circumferential highway) under contract to the Illinois State Toll Highway Authority. The state police have considered, but not yet acted on, proposals to reorganize three, and perhaps all four, of the districts into a single Chicago metropolitan district.

In this respect, the state police are not that far behind the DOT. Illinois DOT has a single district that covers the Chicago metropolitan area, but the incident management program is a composite of three different divisions within the district. The Incident Management Office and the Minuteman Patrol fall under the jurisdiction of the Illinois DOT Bureau of Traffic; the communication center under the Bureau of Electrical Operations; and the Transportation Systems Center under its own Bureau of Transportation Systems.

Chicago has no formal mechanism to bring together the managers of the different agencies involved in incident management. An agency-level committee -to which shippers, receivers, and motor carriers were invited as observers -was formed to oversee and coordinate traffic management during the reconstruction of the Dan Ryan; however, this committee folded upon completion of the reconstruction project. Chicago Area Transportation Study, the region's transportation planning agency, sponsors a traffic operations committee. Its primary focus is on planning issues, not operating problems, so it tends to draw managers as opposed to operating personnel. As a result, interagency relationships depend on personal relationships built over the years and reinforced during reconstruction projects, such as the Dan Ryan project.

Clearance Program: Costs and Benefits

The continuity of the Illinois DOT program and the experience of the Minutemen have produced an effective incident management program. Program managers estimate that most incidents, even small breakdowns, are detected within twenty minutes, and clearance times for major incidents have been reduced from four or more hours to about two hours.

In 1988, the Minutemen responded to about 100,000 incidents. Of these, 60,000 involved disabled vehicles; 30,000 were for abandoned vehicles, debris on the road, and fires; and the remaining 10,000 were accidents. The state police, who patrol a larger area of the expressways than the Minutemen and often call private tow trucks rather than the Minutemen for minor accidents, reported 21,000 accidents that year. Of these, about 80 percent were automobile-only accidents and 20 percent were truck-involved accidents. Combination trucks, typically tractor-semitrailers, accounted for 9 percent of all accidents or about half of the truck-involved accidents. The police respond to a large number of incidents; these are recorded on daily communication logs, but are not tabulated.

We estimate that the Minuteman program returns about $17 in benefits for each $1 invested in the program. The total program costs $5.5 million per year. We estimate that the program saves motorists 9.5 million vehicle-hours of delay at a value of $95 million per year. (The costs and benefits of the program are described in detail in Appendix A.)

Improving Detection and Response Times

Most incidents on the expressways are detected by the state police and the Minutemen. Illinois DOT managers estimate that half of the calls for the Minutemen are initiated by the state police and the other half by the Minutemen themselves. However, an increasing number of incidents are being reported to the state police and the Minutemen over mobile phone 911 emergency lines. To tap this resource and shift non-emergency calls away from the 911 lines, Illinois DOT has set up a *999 expressway-emergency number for mobile phone users. Motorists calling this number reach a dispatcher who will take their call and switch it to the Minutemen, state police, city police, or fire department as needed. The program has been set up as a two-year experimental service. The *999 line is currently logging over 7,000 calls per month.

Illinois DOT has experimented with closed-circuit television for incident detection. They concluded that while closed-circuit television is an effective tool for confirming incidents, the requirements for staffing and monitoring an extensive closed-circuit television system make it a costly tool for routine incident detection.

Fast Removal Policy

Illinois DOT removes automobiles and trucks from the expressway as fast as possible. As soon as it is safe to do so, they will tow, drag, or push disabled vehicles to the nearest exit or other safe drop point. They will do so even if there is a risk that they will further damage the vehicle or its cargo. Moreover, Illinois DOT generally does not allow motor carriers the right of first refusal to hire their own towing contractors or to hand pick a load before removing a trailer from the expressway, especially during peak periods. During off-peak periods, the state police and Illinois DOT program managers will allow motor carriers to clear their own trucks if it is done within a reasonable time. Initial concerns about incurring substantial liabilities under the fast removal policy have not materialized. Automobile owners and motor carriers may claim damages from the state, but very few do so.*

Illinois DOT's dominant role in incident and accident clearance has occasionally become a contentious issue with local private tow operators. The Minutemen contend that private contractors do not have the equipment, experience, or incentive to deal quickly with large truck accidents. This was the case when the emergency patrol operation was first developed; however, private tow operators contend that they now have the equipment and experience to provide both light- and heavy-tow services. The state police will authorize private tow companies to remove vehicles from the expressways in non-emergency situations; and all vehicles towed by the Minutemen are turned over to private contractors at safe drop sites near the expressways.

Critical Role of Traffic Information Program

Illinois DOT's traffic information services may have as much impact on reducing incident congestion as the patrol and clearance programs. The DOT's Traffic Systems Center (TSC) routinely provides Chicago's commercial

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* Maryland is the only state that has a written policy on quick clearance. A copy of the Maryland policy is in Appendix B.

radio and television stations with traffic and incident information. During peak periods,TSC provides information every five minutes on congested expressway sections and average travel times from point to point .

TSC provides traffic and incident information to the media by teletype, computer modem, or direct video feed of color-coded expressway congestion maps. The availability of timely and accurate information has made the packaging and presentation of traffic news a commercially viable service. Traffic news is now considered very much a part of the competitive media environment in Chicago. Currently, two all-news-and-traffic stations, nine commercial radio and television stations, and four commercial traffic reporting services are linked to TSC. They, in turn, feed more than fifty other radio and television stations providing regular traffic information reports. Illinois DOT traffic engineers believe that this traffic status information significantly reduces queuing and delays at incident sites because motorists take alternative routes or shift their travel times.

The information system that provides the data to the commercial media is fed by an extensive loop-detector system installed in the expressways. The primary function of the loops is to provide traffic flow data for ramp meters, but the loops can also be used to detect congestion created by accidents and incidents. The first twenty-five detectors were installed on a five-mile section of the Eisenhower Expressway in 1960. The system now has 1,800 detectors (installed at half-mile intervals on the mainline and at each ramp) covering more than 100 miles of expressway.

Building a Regional Incident Management Program

Chicago has established an effective incident management program, but it does not have a coordinated regional program. The Chicago Police and the Chicago Public Works Department manage traffic and incidents on the city's arterials streets; Illinois DOT manages traffic and incidents on the metropolitan expressway; and the Illinois State Toll Highway Authority manages traffic and incidents on the region's extensive tollway system. The links among these agencies for coordinating traffic and incident management are relatively weak. Observers in Chicago believe that the next major challenge for Chicago is to develop an integrated regional incident management program.

Los Angeles

In the 196Os, Los Angeles developed the nation's premiere freeway system, and in the 1970s the California Highway Patrol (CHP) and the California Department of Transportation (Caltrans) set up an exemplary incident management program in Los Angeles. Under this program, CHP has statutory responsibility for overall management at the site of all freeway incidents, and Caltrans is responsible for system traffic control during major incidents and for maintenance support. Clearance for major and minor incidents is done by private tow-truck operators under the direction of CHP. Today, this incident management system is struggling because the resources allocated to incident management have not grown apace with traffic and congestion on the freeways. Los Angeles is now searching for new solutions.

Evolution of the Program

Los Angeles' current incident program has it roots in the Los Angeles Area Freeway Surveillance and Control Project (LAAFSACP). In the early 1970s, many believed that congestion and incidents had reached crisis proportions. In response to these concerns, Caltrans was given a legislative mandate to look at new approaches to managing congestion. A task force was formed, and a number of promising approaches were identified. These became the basis of the federally funded demonstration project.

The initial focus of LAAFSACP was demonstrating traffic monitoring and management techniques, with much of the early effort going to demonstrate that ramp metering could both smooth traffic flow and reduce accidents. The LAAFSACP demonstrations were set up on the forty-two mile triangular loop of freeways formed by the Santa Monica (I-lo), the San Diego (I-405), and the Harbor (I-1 10) Freeways. Loop detectors, ramp meters, changeable message signs, highway advisory radios and, later, closed-circuit television cameras were installed and demonstrated.

During the course of the demonstrations, Caltrans engineers found that they were able to detect incidents, but that while CHP officers and Caltrans maintenance staff were dealing with an incident, no one was managing the traffic around the incident site. Of particular concern to CHP were the secondary accidents that were occurring at the end of the traffic queues. Often these were more severe than the primary incident and greatly compounded traffic congestion. The LAAFSACP program began to focus attention on the management of incidents and the dynamics of traffic flow around the incident site. Site clearance operations were observed, and the traffic queues and vehicle hours of delay triggered by incidents were measured. Caltrans began developing and demonstrating techniques to deal directly with the traffic impacts of incidents. Service patrols in lightweight tow trucks were fielded to speed the clearance of minor incidents, and traffic management teams were trained to set up diversion routes and provide warning to drivers approaching the end of traffic queues.

These early demonstrations evolved into today's major incident response teams, which Caltrans dispatches when CHP expects that an incident will close down two or more lanes of a freeway for two or more hours. The team consists of a supervisor with a radio car and one or more heavy-duty pick-up trucks equipped with traffic cones and changeable message signs to redirect traffic flows. The team can also deploy a truck equipped with a mobile highway advisory radio unit and call upon Caltrans maintenance staff for sand trucks (to absorb oil spills), front loaders, and other heavy equipment as needed. The response teams provide technical expertise in system traffic control and carry with them detailed traffic diversion plans prepared by Caltrans and CHP.

Another product of the LAAFSACP demonstrations was the traffic operations center. The center is jointly staffed by CHP and Caltrans and serves as the information center for the region's freeway system. The center collates information from the loop detectors, traffic meters, and closed-circuit television cameras. It also has access to CHP's computer-aided dispatch system, and can monitor CHP, Caltrans, and commercial radio communications. The center serves as a central point of contact during major incidents; however, CHP's Los Angeles communications center is responsible for mobilizing resources and coordinating with other agencies.

The task force that set up the LAAFSACP program became the nucleus of Caltrans' permanent traffic operations group. The district-level group, originally a spin-off of the traffic engineering department, is made up today of the traffic operations and systems unit, which deals with incident congestion; traffic engineering, which deals with the problems of recurrent congestion; and traffic design, which develops and oversees implementation of traffic engineering and operations projects.

Severe Congestion Creating New Problems

The incident management system that grew out of the LAAFSACP program has served the Los Angeles region well, but today that sys tern is struggling because congestion and incidents have outpaced the resources allocated for traffic and incident management. The Los Angeles incident management system is breaking down, in part, because the nature of the problem has changed. As the freeway system has become saturated with traffic, small incidents have become a substantial problem; delays in clearing accidents are felt over a wider area; more actors are drawn into incident management increasing the potential for jurisdictional squabbles; and the boom and bust cycles created by incidents can no longer be mitigated by traditional traffic engineering techniques.

Dealing With Small Incidents

Small incidents are now as much a part of the problem as major incidents. Small incidents – stoppages caused by cars and trucks that run out of gas, overheat, lose a fan belt, or drop debris on the roadway – may make up as much as 80 to 90 percent of all freeway incidents. These events are random and unpredictable, but their cumulative effect is significant. As the freeway system has become saturated, the impact of small incidents has been magnified. A single car stalled in a lane, even a motorist changing a tire on the shoulder of the road, can slow traffic, create queues, and trigger secondary accidents.

The problem with small incidents is that they are difficult to find and resolve quickly. Caltrans' major incident response teams are organized to handle major incidents, not minor incidents. CHP locates many small incidents and can push a stalled car from the travel lanes to the safety of the shoulder, but the police cruisers are not equipped to replenish gas or make repairs. For these services, CHP must radio back to their dispatcher and arrange for a private tow truck. Managing even a relatively small number of such incidents takes up a considerable amount of time, and the sheer volume of smaller incidents taxes CHP's capacity even though the department has added 150 officers a year statewide since the 1987-88 fiscal year.

Adding Service Patrols

CHP and Caltrans believe that part of the answer to small incidents may be service patrols. Service patrols on routine beats can locate and respond quickly to incidents, and tow-truck patrols can clear stalled cars and resolve minor accidents as soon as they locate them.

Both Caltrans and CHP would like to operate service patrols: Caltrans arguing that they are critical to their system management functions; and CHP arguing that service patrols are a direct extension of their statutory responsibility to provide assistance to motorists on the freeways. Both agencies are also keenly aware of the public relations value of service patrols: Caltrans looks to service patrols to offset the public's frustration with construction and reconstruction projects that seem to add inexorably long delays on top of the existing congestion; and CHP looks to patrols as a way to help balance out the resentment generated by routine law enforcement actions, such as handing out 55-mile per hour speeding tickets.

But while service patrols are effective, they are also labor intensive and, therefore, expensive. So the question becomes "Who can pay for them?" Within Caltrans, funds for traffic operations, including service patrols, come out of the regular operations budget. Funding is generally stable, but as in many government agencies, maintenance and operations are often sacrificed when budgets are tight. Traffic operations and incident management have often had to do with less rather than more. Caltrans has fielded interim service patrols for reconstruction projects using federal project funds, but these funds are always tied to construction budgets and lapse when the project is complete. They do not provide a stable funding mechanism for permanent operations.

CHP, which does not have access to construction funds, has cobbled together a number of service patrol programs using grants and regular operating funds. CHP has also made direct budget requests to the state for service patrol funding, but it has been a difficult sell in the era of tight state budgets. Nor has it been easy for CHP to maintain their service patrols once they have them underway. In several programs, they found that their service patrol operators were routinely being hired away by private tow-truck operators, motor carriers, and local government. By training their service operators to CHP standards, CHP had inadvertently created a work force that was very attractive to private industry.

CHP has side stepped these problems for the moment by refocusing the job of its patrol officers during the peak periods. Until recently, CHP stressed the importance of "in view" patrols that use marked CHP units when apprehending speeders and issuing tickets, but on congested urban freeways the mere presence of a patrol car with flashing lights causes people to slow down and gawk, creating additional congestion. CHP is now stressing the importance of keeping traffic moving and has shifted its emphasis during the peak hours from law enforcement toward traffic management.

Under its CLEAR (Clear Lanes Efficiently And Rapidly) program, CHP creates flexible, short-duration teams that can quickly get at and resolve traffic problems on chronically congested freeways. When an incident occurs, the beat officer can call for assistance from a "clear unit," usually a motorcycle officer and a patrol car officer drawn from adjacent beats. The objective for the team and the program is to keep traffic moving by handling incidents as quickly and safely as possible. CHP believes that the program is having a positive effect. They cite as one measure the fact that with better deployment and faster response times they are reaching and resolving more minor incidents than they were before implementation of the CLEAR program.

The debate over who should fund and control service patrols is going to go on for sometime; however, more of the burden of paying for incident management may eventually be borne directly by those involved in incidents. For some years Caltrans has been billing motor carriers and their insurers when accidents have caused physical damage to state property. Now Caltrans is billing motor carriers for the costs of incident management. To date, the collection attempts have been selective, focusing on major incidents where there has been considerable damage and congestion. In the future, collection attempts are likely to increase and, perhaps, include smaller incidents.

Clearing Incidents Faster

When freeways are saturated with traffic, as they are during the morning and evening commute periods in Los Angeles, delays in clearing incidents are felt over a wide area. Queues build up quickly and spread rapidly to connecting freeways and adjacent arterials. Incidents that yesterday blocked a single facility today create a real risk of gridlock for large portions of the freeway system. This has put a higher value on being able to clear incidents in the shortest possible time.

Getting the right tow truck to the right place at the right time is part of the answer, but many in CHP and Caltrans regard the acquisition of tow services as the weakest link in their incident management process. CHP does not contract for tow services; all services are provided by private tow operators. When a tow is needed, CHP must call one from a rotation list. Two lists are maintained: one for heavy-duty equipment operators; the other for light-duty equipment operators. Within the City of Los Angeles, CHP draws down from the rotation lists of the official police garages. Outside the city, CHP area commands define their own tow districts and maintain their own tow-service rotation lists.

The system works, but the present procedures do not always guarantee either the right equipment or the nearest available equipment. The next tow service on the rotation list may be some distance from the incident site and may not arrive with the right equipment, especially when heavy equipment is need to clear truck accidents.

These problems have prompted CHP to examine their tow districts and procedures to minimize travel time and cases of mismatched equipment. CHP is giving more attention to pre-qualifying tow-truck services; refining the rotation list by capability (light, heavy, super-heavy, etc.); and giving officers greater latitude and discretion in determining the type of tow service that should be called. CHP can drop poor performers from the rotation list to make this threat more effective, and CHP is tightening up its performance standards. It is also increasing the frequency and detail of its tow inspections and considering the introduction of minimum training standards for tow-truck operators.

Improving Communications

Another way to speed up clearance operations is to make better use of communications technology to detect and respond to incidents. CHP and Caltrans units are equipped with two-way radios. In addition, the Los Angeles incident management system utilizes passive motion-detection loops, closed-circuit television, roadside callboxes, and mobile phone 911 lines. Loops (installed to drive the ramp meters) can detect major incidents where traffic is brought to a halt, but are less reliable for small incidents, which must be verified by the CHP. Caltrans has installed closed-circuit television cameras in high incident areas to cut down the time required to verify and identify problems, but the camera systems are expensive and difficult for operators to monitor over long periods of time.

The majority of freeway incidents are reported through roadside callboxes. The first callboxes were installed in the Los Angeles area in 1965. Under the state authorizing legislation for the callbox program, the counties design and locate the callboxes; Caltrans reviews the plans; and CHP operates the system. CHP's Los Angeles communication center currently handles over 65,000 calls per month from the freeway callboxes. Center managers estimate that 80 percent of the calls are for assistance with gas, flat tires, and minor repairs; and 20 percent of the calls are emergency calls.

CHP and Caltrans are watching with interest the increasing use of the mobile phone 911 lines. All mobile phone 911 calls go to CHIP's communications center (all other 911 calls go to the nearest local police station). The Los Angeles communications center is currently receiving 20,000 calls per month over the 911 lines. Center managers estimate that 85 percent are calls for CHP concerning incidents; 10 percent are for fires or crimes out of CHP's jurisdiction; and 5 percent are non-emergency calls.

For each major incident, the communications center may receive six to ten calls, usually from private citizens or drivers of local delivery and courier services. Many calls are received before CHP or Caltrans units in the field discover the problem. To make better use of mobile 911 calls, CHP and Caltrans are considering posting more frequent mile markers to make it easier for motorists to pinpoint the location of incidents.

Improving communications among the operating agencies may also reduce the time required to clear incidents. CHP and Caltrans are exploring two improvements. The first would establish a state highway operations center to house the traffic operations center and the communication groups from CHP and Caltrans Maintenance. The traffic operations center and Caltrans Maintenance communications group have adjoining facilities in Caltrans' downtown office, but CHP's communications center is located in a separate building some miles away. The new facility would bring all three groups into the same building. The major organizational objective of the move would be to bring the parties together in a jointly staffed facility and improve face-to-face communications as well as electronic communications.

The second communications improvement would be to equip CHP and Caltrans field units with mobile telephones. At present, CHP units at an incident site cannot talk directly to Caltrans units in the area except by relaying messages through their respective dispatchers. Mobile phones would provide a common communications link as well as direct access to other parties, such as motor carrier dispatchers and hazardous materials experts.

Dealing With Jurisdictional Squabbles

CHP and Caltrans use a team approach to incident management. CHP has statutory responsibility for overall management at the site of all freeway incidents, and Caltrans is responsible for system traffic control during major incidents and for maintenance support. The agencies have been careful to nurture this working relationship, which has been basic to the success of their incident management program. Both agencies have used Los Angeles as a training ground for CHP and Caltrans staff from other areas.

This team approach works well if team members are in frequent contact with each other and come to know and rely on the others' capabilities. But as congestion has increased, more actors have been drawn into incident management, and each of these parties brings new priorities to incident management, increasing the potential for jurisdictional squabbles. All too frequently, interagency squabbles have led to delays in clearing incidents and increased costs for agencies and motorists alike. In Los Angeles, as elsewhere in the country, the major new element in incident management has been the interjection of environmental and public health agencies, whose mandates to protect public safety are defined by environmental and health issues, not by transportation system efficiency and motorist services. While incidents involving hazardous materials are relatively infrequent, time-consuming squabbles among agencies over priorities and procedures are not.

Defining Lines of Authority

CHP's response to this problem has been to seek better definition of the lines of authority for incident management. They have found that clearly defined lines of authority provide a base upon which to build team operations. CHP is promoting the concept of an incident command system. The system defines the lead agency for incident management, but stresses the need for a coordinated team approach that brings all skills to bear on the problem. The incident command system gives the team leader both the option and responsibility of inviting others to join a unified command, and it emphasizes the responsibilities of team members to contribute productively to the team. CHP hopes to have the system implemented into CHP's operations by the end of 1990.

A device that reinforces the team approach is contingency planning. Caltrans has found that having a traffic diversion plan available at the site command post helps pull the team together. It provides a means of focusing attention on the substantive issues rather than personalities and bureaucratic turf. But making plans available has become a problem in its own right. Caltrans estimates that it has over 3,000 traffic diversion plans on file for the Los Angeles area alone, far more than CHP and Caltrans staff can carry in their vehicles. Caltrans would like to transfer the plans to a computer database, use GIS (geographic information systems) software to retrieve plans, and then use mobile telephone and fax technology to send specific diversion plans from the traffic operations center to field units.

Dealing With Boon and Bust Cycles

Caltrans has found that the boom and bust cycles created by incidents can no longer be mitigated entirely by traditional freeway engineering approaches. These traditional approaches focus on managing the supply (capacity) of freeways: eliminating bottlenecks and adding lanes to increase capacity; installing ramp meters and positive traffic controls to stabilize traffic flows and maximize throughput; and providing adequate storage space on ramps to handle queues when traffic slows down. These techniques are usually effective at containing the situation under moderate, steady-state traffic conditions. But when the freeway system is saturated, as during evening rush hours, traffic backups overflow onto local streets and can ripple through the system triggering backups on other freeways. This situation has forced Caltrans to look to other solutions.

Using Information to Influence Travel Demand

Caltrans is exploring greater use of information to influence travel demand: providing more accurate and more timely information on incidents and congestion to get motorists to take alternative routes or reschedule trips. This approach is at the core of the Smart Corridor demonstration project being developed by Caltrans, CHP, the City of Los Angeles, and the Los Angeles County Transportation Commission. The demonstration will instrument the Santa Monica Freeway (I-10) and the parallel arterial streets between downtown Los Angeles and the San Diego Freeway (I-405). The key objective of the demonstration will be to determine if information on traffic flows can be collected and disseminated quickly enough to influence traffic flows. The lessons learned from the demonstration will be applied regionwide.

Caltrans is using local highway advisory radios (HAR), mounted on pick-up trucks, to communicate information to motorists directly affected by major incidents. HARs are effective in these situations because they can transmit more selective information than can commercial radio stations, which have limited time for traffic reports and must broadcast to the entire region. But HARs are much less effective at influencing traffic at the corridor and regional level. Motorists usually tune to the HAR frequencies only after they are stuck in a traffic jam and then discount the information because many HARs use canned message loops. The future of HARs in Los Angeles is uncertain. The FCC is considering proposals to shift the HAR frequencies from 530 and 1610 AM to 450 and 1700 AM as part of an effort to allocate more of the frequency spectrum to commercial radio broadcasters. This would put the HAR frequencies out of range for many motorists until new radios are introduced to the automobile fleet.

CHP and Caltrans believe that a more promising approach is to build closer working relationships with Los Angeles' commercial radio and TV stations. CHP and Caltrans provide information on congestion and incidents through their commercial radio advisory service. This has been a permanent program for some years, but CHP and Caltrans have moved recently to strengthen it. CHP is now chairing monthly meetings attended by CHP, Caltrans, and the region's radio and TV traffic reporters. Examples of topics discussed at recent meetings were the need for uniform designation of freeways; the need for more timely information about planned construction work; the lack of accuracy about the duration of delays; and concerns about overwhelming drivers with information, much of which may be irrelevant for an individual driver's commute.

In an effort to target traffic information to motorists, Caltrans will soon begin a demonstration using teletext technology. The objective is to make traffic information and incident advisories available to motorists before they leave their offices and homes. Initially, monitors will be installed in building lobbies, but the eventual goal is to make the information directly available in homes and offices, including motor carrier dispatch offices.

Setting Statewide Policy Direction

Public concern about congestion and incidents in Los Angeles is high. Congestion is consistently ranked among the top two or three issues in public polls, and there have been a number of recent proposals and studies dealing with various aspects of congestion. During the 1987 mayoral election campaign, Los Angeles' Mayor Bradley proposed banning large trucks from the freeway during peak commute periods as a measure to relieve congestion and air pollution problems. More recently, the mayor and the city council have instructed the city's department of transportation to investigate the feasibility of a truck permit program that would restrict the number of large trucks that motor carriers could operate on city streets during the peak periods. The South Coast Air Quality District, under strong pressure to clean up the air in the Los Angeles basin, has taken broader aim at transportation congestion. It is calling for mandatory ridesharing and considering mandatory night shipping and receiving regulations for business and industry.

These proposals have triggered a broad-ranging debate at the state level on congestion and incident management. In 1988 Caltrans undertook a study of the impacts of large trucks on peak-period congestion.** The study identified the costs and benefits of strategies to deal with urban freeway congestion. The strategies included better traffic management; expanded incident management; mandatory night shipping and receiving; and peak-period freeway truck bans. The study recommended that the state consider expanding and intensifying its incident management programs, arguing that these programs would have an immediate and cost-effective impact on reducing delays from incidents.

** **"Urban Freeway Gridlock Study."** Cambridge Systematics, Inc., December 1988.

Acting on the study's recommendation, the state legislature requested that CHP and Caltrans review the state's incident management efforts and recommend improvements. To support the review, the legislature appointed an advisory committee with representation from state agencies, city and county governments, highway users, business and industry, and the motor carriers. This committee is taking a broad look at congestion and incident management. It is expected that the committee and agency recommendations will set new directions for incident management programs in Los Angeles and other California cities.

Fort Worth

Incident Clearance Program

Fort Worth's major incident clearance program is considered by many to be the most aggressive and successful program in Texas. The program was started in the 1970s after a series of major incidents blocked highways around the city for several days at a time.

Responsibility for major incident clearance rests with the Texas State Department of Highways' (SDH's) district safety coordinator and his deputy. Most observers in Fort Worth credit the success of the program to the experience and longevity of the district safety coordinator. This two-man team, on call twenty-four hours a day, responds to all major incidents and accidents on the highway system. The coordinator's office monitors the police radio and is often called directly by the police. The coordinator also has a police radio in his car and gets information on the incident and clearance requirements directly from the patrol on the scene.

When a major incident occurs, the fire department is usually the first agency on the scene and is responsible for providing first aid. When the police arrive, they conduct an investigation and, in the case of minor incidents and accidents, will order a commercial tow service to clear the site. If it is a major incident, the district safety coordinator will locate the appropriate clearance equipment, handle traffic around the incident site, and notify radio and television stations of the incident from a cellular telephone in his car. (If the incident occurs during the business day, the public relations staff at the district offices handles calls for the coordinator.) The safety coordinator has developed diversion routes for the Fort Worth highway system and will set up the appropriate traffic diversions during the course of an accident clearance effort.

The Fort Worth district puts a high priority on clearing the highway of incidents as quickly as possible. To do this, they will call to the incident site any equipment that is necessary for clearance, whether it is SHD equipment, commercial tow equipment, or equipment belonging to private contractors who may be working on nearby highway projects. The primary criteria for selecting equipment are travel time to the incident site and capacity to handle the operation.

As in Chicago, if the initial tow is done by SDH or contractor's equipment, it is to a "safe drop" location only. Once the vehicle is moved to a safe location off the highway, the automobile owner or motor carrier must arrange with a commercial tow operator to have the vehicle towed for repair. These tows are usually arranged by the city police,who have enforcement jurisdiction over all highways within the city limits. According to SDH managers, when the police call a commercial tow service, they do not use tow rotation lists; they select tow services by proximity to the incident site and reputation of the tow company.

To date, Fort Worth's quick clearance policy has not generated a significant number of liability claims. District officials believe that their mandate to provide for public safety and traffic management gives them adequate authority to clear the highways quickly. The Fort Worth district bills motor carriers for the cost of clearing a major incident. District officials estimate that they recover 90 percent of their clearance costs. Trucking companies are credited with being fairly responsible for bearing the damage and clearance costs.

The district safety coordinator also directs a courtesy patrol that provides free service to motorists. Two pick-up trucks equipped with directional arrows, traffic cones, and basic repair equipment operate twenty-four hours a day on the Fort Worth area highways. The patrol clears minor incidents and assists with traffic management during major incidents. The district believes that by quickly clearing stalled vehicles from travel and breakdown lanes the patrol prevents about half of the secondary accidents that might otherwise occur.

Traffic Management Team

Fort Worth's incident clearance program was the springboard for the establishment of a traffic management team for the district. This in turn has led to the development of a comprehensive traffic management program. The clearance program set the stage by building working relationships between the SDH and the city police agencies in Fort Worth and Arlington, the district's major cities.

The first meeting of the Fort Worth area traffic management team was held in September, 1979. The objective was to "work toward the optimum movement of people and goods within freeway corridors so as to obtain the high degree of mobility needed to improve the well being of people and to maintain and increase the economy of the cities." There are now fifteen members on the Fort Worth area team representing District 2 of the SDH, Tarrant County, and the cities of Fort Worth and Arlington. Although there are no formal agreements among the member agencies, the traffic management team coordinates interagency activity and helps set program and policy directions for the four SDH district offices represented on the team.

The original objective of the traffic management team was to deal with congestion problems related to incidents in specific corridors, but the team has also become the forum for developing highway system operating goals and improvement plans. This planning process has served to cement the foundation for long-term interagency cooperation.

Traffic Management Program

The traffic management team has developed a comprehensive, high-technology traffic management plan for the Fort Worth metropolitan area. The plan is being designed and implemented as part of a massive highway reconstruction effort. Many of the highways in the metropolitan areas were built in the 1950s and now need complete reconstruction because of age and rapid regional economic growth. The traffic management plan was submitted and approved in 1985. The first reconstruction project incorporating the new traffic management equipment was completed in 1989.

The traffic management system envisioned by the Fort Worth team consists of four elements: a remote sensing and surveillance system that will constantly monitor the operating conditions on the highways; an interactive control network that will allow for the implementation of corrective actions as highway conditions deteriorate due to recurring congestion or an incident; a joint city-state command center (the traffic management center) that will coordinate activities on both the highways and city streets; and an area-wide communications network that will link all systems to the traffic management center and provide a central contact point for other agencies.

The primary enforcement agency, the Fort Worth city police, will share direct operational control of the traffic management center (TMC) with the SDH district. The district traffic management team has located the TMC in the basement of the Fort Worth Police and Courts Building. Smaller monitoring facilities will be located in the district's headquarters and in the city of Arlington. The TMC will be staffed twenty-four hours a day by police and district personnel. The TMC staff will monitor both city streets and area highways.

The TMC will monitor the freeways through loop detectors, which will be installed at one-half mile intervals in all lanes, and closed-circuit television. If intervention is required, it will be done by activating variable ramp meters, changeable message signs, highway advisory radios, lane use signals, and through adjustment of the system's signal-timing system. The courtesy patrol will be run directly from the TMC when the facility becomes operational.

Traffic information is now disseminated to local radio and television stations through Metro Traffic, a commercial traffic reporting service. The district and city police telephone travel time and congestion information to Metro Traffic, which then relays the information to its member stations for broadcast during traffic-bulletin time slots. Stations that do not subscribe to Metro Traffic are telephoned separately, either by the district or the police. Once the TMC is operational, the district plans to provide real-time traffic-advisory information directly to Metro Traffic, local commercial media, other government agencies, and major employment centers over TMC's communications network.

Anticipated Benefits

The district believes that the benefits of their extensive traffic management program will be well worth the construction and implementation costs. They estimate that the traffic management projects will cost a total of $53 million. The projects include equipping 161 miles of freeway with loop detectors; installing meters at 207 ramps; providing controllable signals on frontage roads and changeable message signs at key decision points along the freeways; mounting 80 closed-circuit television cameras; wiring lane control signals; purchasing and installing a highway advisory radio system; setting up a data collection facility; and expanding the courtesy patrol.

The cost of the traffic management program is estimated to be less than three percent of the total highway reconstruction costs for the region, which are estimated to be about $2 billion. The district anticipates that the annual maintenance and operation of the traffic management system will amount to about eight percent of the installation cost. The initial costs will be lower, but will increase over the next twenty years as highways are reconstructed and the elements of the traffic management system are installed.

The district is looking at long-term options for funding the traffic management system. Federal funds are available for planning, design, and installation of the system, but do not cover long-term operations and maintenance. The state must identify a stable source of operating funds after the reconstruction effort is completed. This is expected to be a long and difficult process.

The district estimates that when the reconstruction is completed the traffic management program will save 156,000 vehicle hours of delay per day and reduce accidents by thirty percent. They also hope to increase the volume of vehicles that can be handled per hour by twelve to twenty percent and make possible a ten-mile-per-hour increase in average travel speeds.

State Policy

The Fort Worth incident and traffic management programs are among the strongest programs in Texas. In large part, this reflects the high priority given to these programs by the district. Within the Texas State Department of Highways and Public Transportation, each district operates with a great deal of autonomy and programmatic independence. In 1984 and 1985, the SDH directed each of the state's twenty-four districts to establish annual goals for improving traffic management, but left program design and implementation to the discretion of the district engineers. Some districts have implemented comprehensive programs while others are still in the developmental stage.

The effects of this policy are evident when one compares the incident and traffic management programs in Fort Worth and Dallas, whose highways are managed by different SDH districts. Both Fort Worth and Dallas are anticipating major reconstruction periods, and both districts are using federal money to develop traffic management programs in conjunction with their reconstruction projects. However, the programs have developed at very different rates, reflecting different local priorities. In Dallas, the traffic management team, which consists of eleven members, has been meeting for just over one year. At this point, the traffic management team is serving primarily as an information clearinghouse for member agencies. The Dallas district office is optimistic that the North Central Expressway reconstruction project, due to begin in 1990, will serve as a catalyst for more team planning and the development of a full-blown incident management program. The district is working with the Texas Transportation Institute on elements of that program.

Minneapolis

Strategic Approach: Investing Now to Stay Ahead of Congestion

For years the Minnesota Department of Transportation has watched other cities struggle to cope with overwhelming congestion problems resulting from traffic growth and incidents on urban freeways. In an effort to stave off the impacts of similar congestion on the Minneapolis/St. Paul freeways, the Minnesota Department of Transportation (MnDOT) is investing heavily in a proactive strategy that it hopes will keep it ahead of the growing congestion in its area. The department is developing a premier, state-of-the art traffic management system that will regulate the flow of traffic on the freeway system for the entire Twin Cities metropolitan area. Using the latest technology in closed-circuit television, loop detection systems, and satellite communications, the department hopes to build a traffic management system that will be among the best in the country. MnDOT has prioritized its traffic management projects based on studies of annual freeway volumes, travel times, and accident rates. System development is taking place on a large scale, through a series of multi-corridor contracts.

The initiative that culminated in this energetic approach to congestion management began with a strategic planning process within MnDOT. The strategic plan originated when the State Legislature turned down the department's funding requests for new freeway construction and expansion in the Twin Cities area. In lieu of a multi-million dollar capital investment, the department revised its approach and decided that its only recourse was to manage the available roadway system.

The strategic plan defined three primary objectives for the department: secure stable departmental funding sources; enhance freeway safety for drivers and highway workers; and reduce congestion in the Minneapolis/St. Paul area. With the support of the governor, the department's new administration appointed a task force to develop an action plan to deal with congestion and incidents. Because of prior work done by MnDOT operations personnel, the task force was able to quickly develop an outline of the operational specifics of their plan.

The strategic plan and the task force's recommendations led to the reorganization of the department. In the past, MnDOT had divided the Minneapolis/St. Paul area into two transportation districts; one for each city. As the department began planning and development of the traffic management program, it found that this organization was not working effectively. With strong internal support, the department was able to combine the two districts into one new Metro Diskict. This enabled it to pursue a comprehensive and coordinated approach to its congestion management program.

MnDOT's strategic approach echoes what is occurring in several other areas of the country. There is a national shift away from construction **and** maintenance as the sole means to solve congestion problems towards maximizing operational capability. Transportation agencies are redefining their role to be traffic service management encompassing civil engineering, traffic engineering, traffic management, and safety. The roadway user is considered a "client" of the kansportation agency. This transition to a service agency orientation is due in large part to the skyrocketing capital costs of constructing new highway systems, as well as increasingly stronger and widespread environmental concerns about the effects of traffic congestion on air quality. One aspect of this shift toward operations is the emerging interest in intelligent vehicle highway systems (IVHS) – the development of "smart cars" and "smart highways" as a way to eke more capacity and productivity out of existing roadway systems.

Incident Management As Part Of A Multifaceted Program

The deparhnent views incident management as part of a multifaceted traffic services strategy. Because the costs of freeway construction are so high, MnDOT directed its traffic operations and engineering personnel to explore the viability of any service initiative that might reduce the impacts of incidents on the system and cost less than $5 million to implement. The Highway Helper program is one of these smaller, entrepreneurial initiatives. Its six vehicles – light pick-up trucks with gas, water and light repair equipment – patrol sixty-one miles of freeway during the morning and evening peak periods. They rescue stranded motorists and remove stalled cars during the heavy commuter periods around the Twin Cities. This program is credited with making over 7,000 assists since it was instituted in 1989.

MnDOT is betting that by investing heavily in traffic management systems it will be able to significantly reduce the frequency of incidents. The department started operation of its traffic management system in 1974. It is now expanding its system and aggressively pursuing the installation of state-of-the-art traffic monitoring technologies. A system of loop detectors and ramp meters has been installed to control the flow of traffic. Over 130 ramps are currently metered, and more than 200 ramps will be metered by 1991. The entire 200 miles of freeways and another 40 miles of arterials will be connected by a fiber-optic communication network and will be under camera surveillance by 1995. MnDOT has developed a network of changeable message signs and closed-circuit television cameras (CCTV) strategically located throughout the freeway system. The loop detectors, signs, and CCTVs will be run from the traffic management center (TMC). Currently being enlarged, the TMC will have forty CCTV monitors, a switcher to control the cameras, computer graphics, and computers to control the ramp meters and signs. The department is also working closely with the Center for Transportation Studies at the University of Minnesota in the development and testing of a video image-detection technology called Autoscope, which automatically counts vehicles. This technology may ultimately replace the loop detector system used to monitor traffic flow and detect incidents. MnDOT is planning to add this capability to the TMC in 1991. In addition, GUIDESTAR, an intelligent vehicle highway system program, is being implemented in concert with the traffic management program.

It is still too early to know whether any individual component or combination of technologies will have the effect that the department is seeking because most of the traffic management program components are currently being installed and evaluated. But in the department's view, the certainty of rapidly increasing traffic volumes in the Twin Cities area leave it no alternative but to try a broad management attack on congestion problems. In this respect, Minnesota is one of number of states attempting a broad systems approach to solve congestion problems. Washington State, Maryland, and Virginia are also developing their traffic management programs with a similar multifaceted approach.

Building New Interagency Relationships

MnDOT's experience with several of its initiatives has brought home to the department the fact that it needs to develop new interagency relationships. This is particularly evident where its growing role in developing and implementing traffic system programs conflicts with the traditional roles of other agencies and jurisdictions. Three of the department's recent projects – installing roadside callboxes, locating new accident investigations sites, and developing joint ventures with Minneapolis area radio and television stations – illustrate the problems and opportunities in building new interagency relationships.

Callboxes: Building New Relationships with the State Police

One of MnDOT's early initiatives was to demonstrate a system of push-button callboxes that were placed at regular intervals along a 22-mile section of the freeway system. The callboxes were developed and installed by the department. However, the callboxes are answered by the Minnesota State Patrol dispatch center; and the State Patrol is responsible for responding to callbox calls. After the callbox system was operational, the State Patrol's ambivalence about the system surfaced because they felt that it did not adequately address all their needs. Push-button technology did not allow the dispatch center to gather enough information about the nature of the incident or accident being called in; often people left the callbox site after the call was made so that State Patrol time was wasted; and many of the calls coming into the State Patrol dispatch were inappropriate for State Patrol action. A total of 573 calls were recorded through December of 1989, an average of 4.3 calls per day. Of these calls, 348 were for motorist-aid service; 158 were for the State Patrol; 8 were medical; and 59 were for a combination of services.

It is clear to MnDOT now that had the Patrol been brought into the development of the callbox project earlier, perhaps during the feasibility and design stages, many of the difficulties being experienced by the Patrol might well have been addressed before installation of the system. The State Patrol has since suggested that the department reconsider the value of the callbox system and perhaps investigate the development of a cellular telephone program, as well as expanded use of mobile phone 911 lines. MnDOT is planning to do this in its evaluation of the callbox demonstration, and will use this experience as a starting point to build a new planning process with the State Patrol.

Accident Investigation Sites: Building New Relationships with Motorists

The department is also demonstrating a system of twenty accident investigation sites. An accident investigation site is an area off the freeway where the police and motorists can conduct an accident investigation without danger of being hit by vehicles on the freeway. Accident investigation sites also help to diminish "gaper's block" by removing vehicles from the side of the freeway to an area out of the sight lines of the travelling public. Ideally, accident investigation sites are not far off the freeway, easily located, well lit, safe, and have a telephone.

In an effort to cooperate with local jurisdictions, the department selected sites that were good solutions from a land use and neighborhood perspective, but not necessarily ideal sites for highway motorists. When developing locations for the accident investigation sites, the department was aware that spotting sites in heavily developed freeway corridors would be difficult. The department worked closely with local officials to select sites that would be acceptable to local neighborhoods. The goal of site location was to produce sites that highway motorists will use, but because of local land use considerations, some of the sites are a considerable distance from the freeway. Some MnDOT officials are concerned that people not familiar with the area will hesitate to use the more distant sites.

MnDOT now faces a long program of public education about the accident investigation sites. Many motorists believe that they should not remove their car from the scene of an incident, particularly to a site off the freeway, until a police officer completes his investigation. As a result, there has been very little use of accident investigation sites by the travelling public on a voluntary basis, although the State Patrol is beginning to use some of the better-located sites.

As in any state, working with local jurisdictions to implement a project requires considerable effort. Each jurisdiction has its own concerns and issues, and what is considered important by a state agency may not be a priority to a local town, city agency, or neighborhood group. This has been brought home to the department through the accident investigation site planning process. It became clear that a firm understanding of what appeals to the highway user is critical, as well as an understanding of the needs of both highway engineers and local neighborhoods. MnDOT believes that providing a forum to adjust or augment preliminary decisions will ensure long-term program viability.

Commercial Radio and TV Joint Ventures: Building New Relationships with the Private Sector

Traffic reporting in the Minneapolis/St. Paul area has not developed as competitive an edge as it has in Chicago and Los Angeles because traffic congestion is less severe in Minneapolis/St. Paul. Traffic information is only broadcast every twenty minutes, and traffic reports are discounted because they are often inaccurate. In part this is because the duration of incidents is short, and by the time the traffic information is broadcast, the situation is often cleared. In addition, in an area where the average commute time in the morning and evening is about 20 minutes, many commuters are already committed to their routes before traffic radio spots can warn them of incidents. A contributing problem is that until the department developed its traffic management system, there was no way that commercial stations could get real-time data to feed into their traffic reports.

The situation in Minneapolis/St. Paul is rapidly changing as the department advances its strategic program. As the traffic management system is activated, the department is finding itself with real-time information that needs to find an effective distribution channel to highway users. MnDOT has been using a high school FM radio station to broadcast "live" traffic reports. This radio provides metropolitan coverage, but reaches only a limited audience. The department found that it was effective for providing coverage during a major incident, which they define as lasting more than an hour, but ineffectual when it came to recurring congestion and covering incidents that last less than an hour. In an effort to expand the broadcast's effectiveness, MnDOT has installed a system of roadside signs equipped with radio-activated flashing lights that advise drivers to tune into the FM station during a major incident.

At the present time MnDOT provides traffic information to local stations and traffic services, which re-broadcast the information, as in Chicago. The department has proposed contracting with a commercial radio and television station to broadcast traffic information directly from the traffic management center. The broadcaster would be a MnDOT employee with a broadcasting background. In exchange for direct access to the traffic information provided by the center, MnDOT wants to negotiate access to traffic observers in the station's helicopters. Eventually, the department would like to work out a pooling arrangement with the station and other media so that the entire metropolitan area is not left without aerial coverage when the commercial media rush to cover a major incident during peak commuting periods.

MnDOT's bidding process and the proposed contract were immediately challenged by a local competing traffic reporting service, Although it is not certain what form the final arrangements will take, it is clear that, because of its new data collection capability, the department will play an increasingly central role in traffic information dissemination, either through its own (contracted) media facility or through a new agreement with the existing traffic reporting services. The issue for the department is to determine the best form of public-private partnership to deliver what it considers to be a critical level of traffic information to the travelling public.

Redefining the Role of the State Highway Patrol

MnDOT's sister agency, the Minnesota State Patrol, has been forced to redefine its enforcement role because the department is quickly developing a broad operational role for itself in traffic management. The State Patrol was chartered in the 1920s as a highway patrol operation to assist motorists and enforce motor vehicle traffic laws. Originally part of the State Highway Department, the State Patrol was transferred to a newly created Department of Public Safety in the 1970s. As the State Patrol's policing powers increased, so too did the organizational emphasis on protecting individual citizens and property. Now, with the task of managing congested highways becoming more important, the State Patrol is reconsidering the effect of its law enforcement procedures on highway operations. In particular, the State Patrol is reviewing changes to three of its traditional procedures:

- Conducting detailed accident investigations on the site. Accident investigations by the side of the roadway, in full view of the travel lanes, can often tie up large sections of freeway as motorists slow down to gawk. This has resulted in secondary accidents at the end of the gawker's queue. When there are no injuries or fatalities and the vehicles can be moved, the State Patrol is urging its officers to utilize MnDOT's new accident investigation sites.

- Stopping motorists for traffic violations regardless of the time of day or roadway conditions. The State Patrol now finds that traffic volumes are such that stopping motorists on congested roads during peak commuter periods slows down traffic and exposes both the motorist and the officer to increased risk of being hit by an unobservant driver. The State Patrol is now evaluating the effect of this policy.

- Protecting the property rights of motorists by allowing car drivers to determine themselves who will tow their vehicle once they have had an accident or incident, and truck drivers to determine how their spilled loads will be removed. The State Patrol will now push a car off to the side of the road, and they are exploring with the department and private industry the use of contract towing services that will guarantee that trucks and loads will be removed expeditiously, even at the risk of damage or load losses. The State Patrol is also considering shortening the length of time it will allow a stalled vehicle to remain on the freeway shoulder.

With no clear state or public mandate on its specific role, the State Patrol is moving cautiously to revise operational procedures that will define a new balance between its responsibilities as a law enforcement agency and its responsibilities as a highway agency.

Future Issues

MnDOT's long-term challenge is to build an external constituency for its programs, using its positive relationships with other agencies to help construct a public mandate for a coordinated, interagency traffic management program. The department enjoys a relatively positive reputation and has an active public outreach program. As part of its traffic management strategy, it initiated a series of outreach activities in 1989 that included an incident management workshop. The purpose of the workshop was to identify new efforts and solutions to congestion resulting from truck accidents and incidents. Participants included the State Patrol, the Minnesota State Trucking Association, twelve metropolitan area cities, several trucking firms, commercial media stations, private businesses, and a citizen association.

As traffic conditions worsen over the next decade and the freeway system approaches saturation levels, the ability to quickly detect, respond, and clear minor incidents will become increasingly important to the operation of the freeway system and to the public's perception of the department. The public outreach program on which the department has embarked can serve as a forum for discussion to develop solutions to these problems.

New York/New Jersey (TRANSCOM)

TRANSCOM, the Transportation Operations Coordinating Committee, is a formal public entity funded and staffed by its fourteen member agencies, which include the Port Authority of New York and New Jersey, the New York State Department of Transportation, the New Jersey Department of Transportation, and the New York City Department of Transportation. TRANSCOM has fashioned a regional incident management capability for the New York / New Jersey metropolitan area. It has done this by acting as a value-added provider of information. TRANSCOM gathers and disseminates information about incidents and traffic conditions. Its clients are ninety-six transportation and traffic enforcement agencies in the metropolitan area. TRANSCOM's services have resulted in improved traffic coordination across the region and a forum for corridor and regional incident planning.

Incident Notification Service

When an incident occurs, TRANSCOM's traffic information center collates information about the incident, assesses its potential traffic impact, and notifies agencies that might be affected. For example, an accident on the Throgs Neck or Whitestone Bridges, which control the northern approaches to Long Island, will be handled by the Triborough Bridge and Tunnel Authority (TBTA), but a call from the TBTA to TRANSCOM will ensure that other agencies up and down the corridor are notified. Depending on the time of day, TRANSCOM's alerts will reach thirty-five or more groups. The information is sent directly to agencies and traffic reporting services using alphanumeric pagers, telephone, and facsimile machines. The pagers can be carried by incident management staff in the field or hooked into a printer in an operations office.

For the participating agencies, TRANSCOM's service saves tirne. Operations managers make only one call, rather than ten or twenty, to ensure that notification procedures are set in motion. Notification is immediate; there is a record of the transaction; and the potential for embarrassing oversights is minimized. Moreover, the early identification of emerging problems gives managers time to react. An incident at the Throgs Neck or Whitestone Bridges will shift traffic westward to the Triborough Bridge, but early notification will give the Triborough's managers time to hold toll collectors over at the end of shift and add police details to handle the additional traffic. For suburban police departments, who may need to set up diversion routes around an incident, TRANSCOM's early notification provides time to call up officers to direct traffic.

Timely information about incidents and traffic conditions is also valuable because the regional highway network is saturated, and even moderately severe incidents can trigger substantial congestion. The problem is acute in the New York metropolitan area because of the region's geography; it is laced together by bridges and tunnels crossing the area's rivers and bays. These facilities are bottlenecks during normal traffic conditions and quickly become chokepoints under abnormal traffic loads.

A major incident on a critical link, such as the George Washington Bridge, which carries I-95 across the Hudson River, can tie up thousands of commuters. One-hundred million vehicles use the fourteen-lane bridge each year, and on an average day 130,000 vehicles cross the bridge in each direction. Incidents that affect the bridge have a direct impact on the region's economy. Among the 130,000 vehicles on the bridge are 15,000 trucks, including trucks carrying most of the fresh vegetables, frozen meats, and other foods destined for points in New York City and Long Island.

Multiple Jurisdictions

Timely information is also valuable because the region must mobilize many agencies to respond to an incident. The New York/New Jersey region is blanketed with jurisdictions. Within the 500 square miles of the metropolitan area served by TRANSCOM, there are 3 states, 23 counties, over 300 municipalities, and nearly 20 independent authorities. Many of these jurisdictions have several agencies involved in transportation and incident management.

Mobilizing and coordinating agencies across jurisdictional lines has long been a problem. Agencies in the region are vociferous about protecting their turf, believing that diversity and independence ensure local control and accountability. Solutions used in other metropolitan areas to deal with regional problems, such as creating new regional authorities or combining the operations of existing jurisdictions, are difficult to implement and seldom attempted. In the past, the price of the diversity of the region was that the left hand often didn't know what the right hand was doing. Transportation agencies in one jurisdiction were, all too frequently, unaware of traffic problems in a neighboring jurisdiction.

Evolution of the Program

The resurgence of the metropolitan economy in the early 1980s provided the impetus to address regional traffic management needs. The economic boom triggered an increase in commuter trips and truck movements across the Hudson: jobs and retail sales were increasing in Manhattan and Long Island while construction of residential housing and warehouses was increasing in the New Jersey suburbs. The Port Authority of New York and New Jersey, which is responsible for the interstate tunnels and bridges crossing the Hudson, recognized the need to expand the capacity of the Hudson crossings. It also realized that the expansion and reconstruction projects would take several years.

The prospect of gridlock, caused by construction projects intended to solve congestion problems, led to the formation of TRANSCOM, the Transportation Operations Coordinating Committee, in 1985. TRANSCOM's initial mandate was to maintain regional traffic capacity. It was to do this by improving communications among its member agencies about planned improvement projects and coordinating the timing of these projects to assure that parallel routes were not under construction at the same time. The Port Authority funded half of the committee's budget; the New York State Department of Transportation, the New Jersey Department of Transportation, the New York City Department of Transportation, and other members funded the other half of the budget.

The Lincoln and Holland Tunnels case illustrates the type of problem that TRANSCOM was formed to address. In 1987, New Jersey DOT was rehabilitating New Jersey Route 495 at the west end of the Lincoln Tunnel. The project had a high priority because it was a critical link between the New Jersey suburbs and the Manhattan central business district. The construction plans called for closing several of the westbound lanes on Route 495 leading out of the tunnel. The closing would have significantly restricted traffic flow outbound from Manhattan and the tunnel.

At the same time, the Port Authority was continuing reconstruction work on the parallel Holland Tunnel. The Port Authority construction plans called for closing the westbound tube of the Holland Tunnel on weeknights and diverting traffic outbound from Manhattan to the Lincoln Tunnel. Although the construction divisions of the two agencies were generally aware of the parallel construction schedules, no one had evaluated the overall traffic impacts. These would have resulted in night-time traffic jams in midtown Manhattan and costly delays for motor carriers and businesses that depend on off-peak deliveries. TRANSCOM identified the potential problems and arranged meetings between the agencies. Construction schedules were subsequently adjusted, and a traffic management plan, which involved local police from the four towns affected by the construction, was developed and implemented.

Today, TRANSCOM maintains a comprehensive data base on its member agencies' construction projects. TRANSCOM plots the projects on corridor and regional maps, analyzes their potential impacts, and if they are significant, makes sure they are brought to the attention of the affected agencies. TRANSCOM disseminates a weekly traffic advisory report on regional projects that may have interagency impacts. The advisory report goes out by fax every Thursday night so that it is available to the agencies on Friday morning as they prepare for the next week's construction activities. TRANSCOM has recently added information about the completion of projects so that agencies know when traffic restrictions are lifted.

Growth of the Program

TRANSCOM has been careful to focus its activities on information about incidents and construction projects, rather than operations or enforcement. It has done this explicitly to minimize jurisdictional conflicts with operating and enforcement agencies. Judged by the volume of business, the TRANSCOM approach has been successful: its client base has grown to 96 agencies; the volume of transactions (measured by the number of incidents put on the paging system) has grown from 130 in 1985 to 3,000 in 1989 and continues to increase. TRANSCOM's traffic information center now operates twenty-four hours a day. TRANSCOM's budget has grown to $1.7 million per year and is now supported by a dozen agencies. The Port Authority, which provided 50 percent of the TRANSCOM budget in 1985, now provides about 20 percent of the total budget, as do NYSDOT and NJDOT.

Contingency Planning

The growth of the program has made it possible for TRANSCOM to expand its role as a broker for corridor and regional contingency planning. The TRANSCOM meetings are the sole forum where New York and New Jersey officials involved in traffic and incident management can meet their counterparts in other agencies and conduct business. TRANSCOM and the agencies have used this as an opportunity to create corridor-level traffic management teams and define formal contingency plans. These plans spell out the actions to be taken by agencies to handle traffic when a major incident closes all or part of a highway. The plans detail notification procedures, establish pre-approved detour routes, and assign responsibilities. TRANSCOM coordinates the implementation of the communications and diversion elements of the plans. The agency on whose facility the incident occurs implements the diversion elements of these plans.

TRANSCOM is using federal, state, and local funds to develop traffic management teams and contingency plans in six critical corridors: the Verrazano / Staten Island / New Jersey corridor; the Raritan River Bridges corridor, including a key section of the Garden State Parkway which provides access to the New Jersey shore area; the I-280 corridor through Hudson, Essex, and Morris Counties in New Jersey; the New Jersey Route 495 corridor, which forms the western approach to the Lincoln Tunnel; the I-287 corridor in Westchester and Rockland Counties in New York, which forms the region's northern bypass; and the Long Island Sound Bridges (the Triborough, Throgs Neck, and Whitestone) which control the northern approaches to Long Island. And recently, the Urban Mass Transportation Administration has provided TRANSCOM with funds to develop a transit-corridor incident management plan.

Building a Long-Term Constituency

TRANSCOM's next organizational challenge is to build a stable, long-term constituency to support its services. TRANSCOM is not an independent agency with its own powerbase and is, therefore, dependent on continuing cooperation and funding from its member agencies. Despite budget problems and changing political administrations among its member agencies, TRANSCOM has succeeded in obtaining increased agency support for the next three years. While there is strong support today, funding cuts, political squabbles, or further changes in political administrations could lead to a loss of agency support and funding for TRANSCOM. Public support for regional traffic management is tenuous because TRANSCOM's services are not visible to the average motorist. The motorist who reads a sign on the George Washington Bridge alerting him to a problem on the New England Thruway is unaware that it is TRANSCOM that is responsible for this timely message.

TRANSCOM is looking to new services to broaden its constituency and funding base. It is currently working with its agencies to coordinate the use of changeable message signs across the region. The objective is to provide information about alternative routes to motorists before they are trapped in congestion. Each time a participating agency adds a changeable message sign or highway advisory radio system, TRANSCOM works to make sure that this resource is available for major regional incidents.

Targeting Information to Specific Markets

TRANSCOM is also trying to target information to specific markets. Under an ATA Foundation demonstration grant, TRANSCOM is providing incident and construction advisories directly to twelve motor carriers that operate in the New York/New Jersey region. The carriers' dispatch offices are linked to TRANSCOM by pagers and fax machines. Preliminary reviews of the program suggest that the information has been useful to carriers who have time-sensitive operations and two-way communications with their fleets. These carriers have used the information to reroute trucks, keep shippers and receivers informed about pickup and delivery times, and improve the efficiency of terminal operations. TRANSCOM would like to expand this type of information service to large employers, providing them with traffic and transit information for their employees.

Applying New Information and Communication Technologies

Finally, TRANSCOM has been working to give the New York-New Jersey region a greater role in FHWA's national research agenda on congestion management. Prior to the establishment of TRANSCOM, attempts to capture federal congestion management grants often failed because the responsibility for administering, managing, and accounting for grants had to be split among many agencies. By designating TRANSCOM as the region's grantee for federal congestion research funds, the region has provided FHWA with a single point of contact and greatly streamlined procedures. TRANSCOM, acting on behalf of New York City DOT, New York State DOT, New Jersey DOT, and the Port Authority, was awarded one of the five congested corridor studies funded by FHWA. The study will focus on the George Washington Bridge-Cross Bronx Expressway corridor, analyzing traffic patterns and recommending congestion management technologies for the corridor.

TRANSCOM was recently awarded a $3 million appropriation from FHWA's research budget for demonstration and evaluation of new technologies that could speed up the collection and dissemination of traffic information. The grant provides for demonstrations of highway advisory radios, video image detection systems, electronic bulletin boards, and automatic vehicle identification technology for faster toll collection.

TRANSCOM has a project underway to develop a geographic information system (GIS). The system would allow TRANSCOM to superimpose information about incidents, construction work, and diversion plans on a video map of the region's roadways. The objective is to make it easier to correlate and interpret complex information. Eventually, TRANSCOM hopes to be able to download incident information in the form of advisory maps. These would be transmitted by video feed or fax from TRANSCOM's computers directly to its clients, including commercial traffic reporting services.

4. Findings and Conclusions

This chapter presents the key findings and conclusions of the incident management study. The findings and conclusions are divided into two groups: findings about the nature of the problem (why better incident management programs have not developed); and findings about solutions (what is being done to improve incident management).

Findings About The Problem

The major impediment to the development of incident management programs is the lack of a clear mandate. Although frustration and anxiety about urban highway congestion are high and there is strong public opinion that 'something needs to be done,' the responsibility for incident management – and traffic management generally – is unfocused. The federal government regards incident management as an operational issue and therefore the prerogative and responsibility of state government. The states, in turn, have usually delegated the responsibility for traffic and incident management to local police and fire departments on the scene. This delegation of responsibilities has worked well as long as incident congestion could be handled within city limits; but congestion is now a metropolitan problem and must be managed at that scale.

Many urban areas are looking to their state transportation departments to take responsibility for metropolitan traffic and incident management, but state transportation departments have been reluctant to do so. Most are preoccupied with their search for funds to repair deteriorating roads and bridges, and metropolitan traffic management is not the traditional business of state transportation agencies. State highway departments have a long-established mandate to build highways, and in the early 1900s state highway patrols were given the task of policing them; but the state agencies generally have not been responsible for traffic management. This is reflected in the staffing of state highway agencies, where the majority of senior managers still are civil engineers, not traffic engineers.

When state transportation agencies have been drawn into metropolitan traffic and incident management, they have had uncertain support. Local jurisdictions have resisted any changes in their traditional roles and responsibilities; motorists have been reluctant to tax themselves for new services; and the trucking industry – fragmented, preoccupied with deregulation, and reactive -has been slow to sort out its interests and find a voice on the issue. Where programs have emerged, they have usually been ad hoc responses to major crises.

In the absence of a clear mandate, marry efforts to develop comprehensive incident management program have been hamstrung by an inability to reconcile conflicting departmental goals and practices. Responsibility for incident management is divided among state police and highway agencies; local police and fire departments; tow-truck operators; hazardous-materials specialists; vehicle and cargo insurers; and public health officials. Each has long-established organizational goals and practices that define how incidents are to be handled. For highway engineers, incident management means protecting the capacity and efficiency of the highway network. For police and fire officials, incident management means protecting individual safety and property rights. For public health and environmental protection agencies, incident management means protecting public and environmental health. And for tow-truck operators and insurers, incident management means a business and a livelihood. Each has a legitimate role in incident management and many agencies are effective and innovative, but all too often duties overlap, authority is fragmented, and actions are inconsistent.

Most metropolitan areas tolerate this patchwork approach and muddle through incident management. But as congestion increases, so does the pressure to change, and this leads to conflicts among agencies reluctant to give up traditional responsibilities and established practices. At best these conflicts only slow the rate of change, but at worst they cause confusion and squabbling at the site of incidents, greatly increasing their duration and impact.

The costs of incident congestion, and therefore the benefits to be gained by reducing incident delay, are not well understood. This undermines efforts to document the need for incident management and build support for incident management programs.

Most metropolitan areas do not have reliable counts of incidents. The incident rates used by FHWA to estimate the national cost of urban incident congestion were, for lack of better data, based largely on research done in the early 1960s. There is no reliable information on current highway incident rates and no current national research on the topic although it is clear that automobile technology and driving habits have changed significantly over the last thirty years.

The traffic impacts of incidents -measured in hours of delay to vehicles on the highway – are seldom documented. Most estimates, if they are made at all, are calculated after the fact using police report data on duration, number of lanes closed, and typical traffic volumes. The direct costs of congestion (lost time and increased vehicle operating costs) can be estimated reasonably well, but the indirect costs to business, industry, and the economy resulting from lost time and increased vehicle costs are seldom estimated because there is limited data on truck movements within urban areas and very little information on how shippers and receivers are affected by delays.

Finally, metropolitan areas do not know the full contribution of incidents to the congestion problem because they do not have consistent and reliable estimates of the extent and economic cost of overall highway congestion. Metropolitan areas recognize congestion as a problem, but do not have a good understanding of its dimensions.

Findings About Solutions

A key objective of the case studies was to assess the state-of-the-art and identify effective approaches to organizing comprehensive incident management. The major findings from the case studies are:

Incident management can be cost-effective. The Chicago Minuteman program returns about $17 in benefits for each $1 invested in the program. It is estimated that the program saves commuters and motor carriers $95 million per year at a cost of $5.5 million per year. In a time of tight budgets, incident management programs that maintain highway capacity are a good investment and may be a better investment in some situations than new highway construction.

There are successful models for developing and operating comprehensive metropolitan incident management programs. The institutional arrangements differ, but each of the programs examined in the case studies has dealt successfully with the need to provide metropolitan-scale traffic and incident management services by reallocating traditional roles and responsibilities.

- Chicago has created an incident management capability within Illinois DOT by coordinating the activities of traditionally separate operating bureaus.

- In Los Angeles, the California Highway Patrol and the California Department of Transportation, two strong and independent agencies, have built a statewide traffic and incident management capability by negotiating a set of formal and informal agreements that have created a strong interdependent team.

- Fort Worth has created a formal multi-agency traffic management team that is functioning as a metropolitan traffic and incident management organization.

- In Minneapolis, the Minnesota Department of Transportation has taken lead responsibility for metropolitan traffic and incident management by redefining the department's strategic role and reorganizing internally to develop new organizational and technical skills.

- TRANSCOM has forged a regional traffic and incident management capability for the New York-New Jersey metropolitan region by providing information services that coordinate incident management but do not challenge the traditional roles and responsibilities of the hundreds of operating agencies in the region.

The key organizational approaches used by successful incident management programs include:

- *Traffic management team* to organize multiple jurisdictions and multiple agencies. Traffic management teams provide a forum for program development without directly challenging traditional agency roles and responsibilities. They are especially effective in the early stages of program development because they are informal, problem-oriented, and do not require participating agencies to commit to a formal reorganization.

- *Traffic operations centers* to coordinate incident management activities at a metropolitan scale. Traffic operations centers are information service organizations that collect, collate, and communicate information on incidents and traffic conditions. They facilitate the work involved in incident clearance and recovery for line managers in police, fire, and highway departments. With good information, managers are able to anticipate problems, marshall resources, and avoid costly duplication of effort. This saves time and makes the managers more willing to participate in incident management programs.

- *Dedicated service patrols* to speed detection and response to incidents, especially small incidents. Service patrols make it possible to respond to incidents quickly; provide a training ground for incident managers; and heighten the public visibility needed to maintain a constituency for incident management programs.

- *Incident command systems, contingency planning, and quick-clearance policies* to minimize interagency conflicts over roles and responsibilities at the site of an incident. Incident command systems, such as California's, define the lines of authority at an incident and make both individuals and agencies accountable for their actions. Under California statutes, the state highway patrol is responsible for overall command at highway incidents. The incident command system gives the officer-in-charge both the option and the responsibility of inviting others to join a unified command, and it emphasizes the responsibility of team members to contribute productively to the team. The California system codifies management practices that have evolved over twenty years and are similar to the lines of authority established by other successful incident management programs.

The major programs make extensive use of written contingency plans. By having traffic diversion plans available at the site command post, attention stays focused on substantive issues rather than personalities and bureaucratic turf.

The most effective programs also have quick-clearance policies. These policies, usually undocumented (Maryland is the first state to have issued a formal written policy), require that roadways be reopened as quickly and safely as possible. The policies provide a common objective for the many different participants – police, fire, tow-truck operators, highway maintenance teams, and hazardous materials experts – drawn to an incident.

- *Partnerships with comnercial radio and television stations to market information to motorists.* The objective of these public-private partnerships is to get information about incidents to motorists before they are caught up in an incident queue, while they still have time to delay their trip or take an alternate route. The partnerships blend the incident management program's ability to collect and organize incident and traffic information with the media's ability to package and market it to a metropolitan audience.

- *Strong service orientation* to build a constituency and maintain a commitment to the incident management program. The successful programs have established a corporate culture that emphasizes their role as a service organization. This is advertised to the public and inculcated in the employees to define the social value of the program and instill pride in the organization.

Effective incident management program can be built using existing technology. New technology is not required. Technology can improve the effectiveness of service patrols and incident management teams, but it cannot substitute for them. New technologies, especially communications technology, are being adapted and applied to improve incident management. Agencies are investing in electronic traffic sensors and computerized traffic controls so that they can monitor and manage traffic flows. They are also slowly but systematically developing the capability to disseminate information on incidents and traffic conditions. By providing drivers the option to reschedule trips or take alternative routes, these driver information systems offer great potential for reducing the congestion impacts of freeway incidents. The systems being assembled by today's incident management programs will form the core of tomorrow's IVHS programs (intelligent vehicle and highway systems).

5. Recommendations

Incident congestion is a major problem, especially in large metropolitan areas. Incidents cause billions of hours of lost time every year; they impose huge economic costs on state and national economies; and their cost is likely to increase in the foreseeable future. Incident management programs can address the problem. The techniques, equipment, and expertise to operate effective incident management programs are available and proven.

The major impediments to the development of comprehensive metropolitan incident management programs are not technical, but organizational and institutional. Once a local problem, incident management has become a metropolitan-scale problem that falls awkwardly between the traditional responsibilities of state government and local government; as a consequence, incident management duties overlap, authority is fragmented, and actions are inconsistent.

A commitment is needed to address the problem and take advantage of the knowledge, skills, and technology that already exist. The states, the motor carrier industry, and the federal government must make this commitment. The investment required is modest; the benefits substantial.

- States and their metropolitan areas must take the initiative to develop comprehensive metropolitan incident management programs. The states alone have the police powers and organizational capacity to develop programs that will be effective across a metropolitan freeway network.

- The ATA and the motor carrier industry must provide strong support for these initiatives. Carriers have an immediate economic interest in minimizing congestion. Moreover, they risk being blamed, fairly or unfairly, by a frustrated public if they fail to exercise leadership on this issue.

- The Federal government must create an environment that encourages initiative and innovation in incident management. The Federal government's National Transportation Policy has made a strong commitment to encourage better management of the nation's transportation facilities and more cost-effective use of the nation's transportation dollars. Incident management provides an opportunity to realize those policies in a way that will contribute directly to the productivity and competitiveness of the nation's economy.

The following actions are recommended to expand and improve incident management.

State Initiatives

1. States should mandate the development of comprehensive metropolitan incident management programs. The objective of the mandate should be to establish incident management as a state priority. In most states, existing transportation statutes provide a solid legal foundation for incident management programs. These statutes typically require state departments of transportation and highway patrols to safeguard lives and property and maintain the safe and orderly flow of traffic on public streets and highways. Incident management programs address these goals directly. Nevertheless, states may wish to consider additional legislation that specifically mandates and authorizes the development of comprehensive incident management programs. The state's mandate should:

   - Recognize congestion as a major problem affecting the social, economic, and environmental well-being of major metropolitan areas.

   - Recognize the role and importance of incident management, and traffic management generally, in reducing congestion.

   - Require the development of comprehensive metropolitan incident management programs that provide for systematic treatment of incident detection, response, clearance, and recovery.

2. States should assign responsibility for the organization and implementation of incident management programs. The objective should be to fill the vacuum that exists today between state and local government responsibilities. The appropriate lead agency will vary from area to area, but typically has been a state department of transportation, state highway patrol, or metropolitan police department.

3. States should establish clear lines of authority for the management of incidents, especially incidents involving hazardous materials. The objective should be to establish accountability and minimize the risk of interagency squabbles at incidents.

4. States should adopt and implement a quick-clearance policy for incidents. The objective should be to minimize the congestion cost of incidents by requiring that roadways be reopened as quickly as possible

to reduce delay. The policy must recognize that public safety is the highest priority and must be secured, especially if injuries or hazardous materials are involved. The policy should give incident managers wide discretion to set performance standards for commercial tow-truck operators; call out equipment; and remove disabled vehicles, spilled loads, and abandoned vehicles quickly.

5. The states should require uniform annual reporting of recurring congestion, incidents, and the congestion impacts of incidents. The objective should be to provide the states with a report card by which they can measure the extent and severity of congestion and assess the effectiveness of their incident management programs.

ATA/Motor Carrier Industry Initiatives

1. The ATA should strongly support federal and state incident management legislation and programs. The objective of this effort should be to focus attention on the importance of incident management to the economy. The ATA should take the initiative to develop a broad coalition within the trucking industry to support federal and state incident management legislation and programs.

2. The ATA should develop an education program on incident management for state trucking associations and private fleet associations. The objective of the education program should be to provide the associations with information so that they can effectively explain and support industry policy on incident management before their state legislatures.

3. The ATA should support quick-clearance policies. The objective of this policy should be to minimize the cost of incident congestion to the motor carrier industry and other highway users.

4. The ATA should expand its technical research and training programs. The objective of these programs should be to provide state departments of transportation, police agencies, and motor carriers with safe and efficient incident clearance techniques, especially for heavy trucks and hazardous materials.

5. The ATA should expand its driver and truck safety programs, such as the America's Road Team program. The objective should be to promote safe truck-driving procedures for congested urban freeways. The programs should encourage motor carriers to implement driving policies

that reduce the risk of accidents by minimizing lane changes; establishing safe following distances; and setting appropriate speeds. ATA may wish to consider developing standards and prototype policies that motor carriers and state agencies could utilize.

6. ATA should research the issue of motor carrier liability and cost responsibility for incidents. Motor carriers believe that they are being billed for all incident clean-up costs whether or not they are at fault. Conversely, state agencies cite concerns about liability for damage to vehicles and cargo as a reason why they should not implement a quick-clearance policy. Actual experience suggests that these concerns are seldom an issue, but there is little definitive information on the topic. The research should determine when, where, why and to what extent motor carriers are held responsible for incident costs. The information will help motor carriers, shippers, and insurers better define the risks of operating on urban freeways, thereby encouraging safer routing and driving practices.

Federal Initiatives

1. The next federal highway act should make funds available to the states to set up or expand comprehensive incident management programs. Funds should cover operating costs as well as capital and equipment costs and should be provided for the duration of the legislation. The objective of the funding should be to encourage effective management of existing freeway systems and provide incentives to state and local governments to look at cost-effective alternatives to construction.

   Funding in the initial two years should be at a ratio of 95 percent federal funds to 5 percent state matching funds. In the succeeding years, the funding ratio for operating expenses should be stepped down to 50 percent federal funds and 50 percent state funds. The objectives of this funding strategy should be 1) to ensure that incident management programs can compete effectively with construction and maintenance programs for state matching funds; 2) to provide states with adequate time to build a constituency for incident management; and 3) to allow states to develop revenues to support the long-term operation of the programs.

   To assure the broadest possible support for incident management programs, funding should be made available to all states and metropolitan areas. However, priority should be given to funding incident management programs in the dozen large urban areas that have the highest freeway congestion costs today (i.e., New York, Los Angeles, San Francisco, Houston, Detroit, Chicago, Boston, Dallas, Seattle, Atlanta, Washington DC, and Minneapolis). Within ten years, fifteen to twenty urban areas from the next tier of cities should also have major incident management programs in place.

2. Federal government transportation policy should explicitly recognize the role and importance of incident management, and traffic management generally, in reducing congestion. Federal highway policy should:

   * Recognize that incident management contributes directly to the nation's ability to meet the goals outlined in the National Transportation Policy.

   - Promote comprehensive treatment of incident management and encourage innovative and systematic approaches to incident detection, response, clearance, and recovery.

   - Encourage the development of uniform incident management practices across states and cities.

3. The Federal Highway Administration should develop and demonstrate methodologies for the uniform measurement and reporting of recurring congestion, incidents, and the congestion impacts of incidents. The objective of this work should be to better quantify the impacts of congestion and incidents.

   As part of this effort, the Federal Highway Administration should require the recipients of federal incident management program funds to measure and report on recurring congestion, incidents, and the congestion impacts of incidents as part of the planning and operation of their incident management programs. The objective of the reporting requirement should be to establish contemporary incident rates.

4. The Federal Highway Administration should focus research, demonstration, and training efforts on incident management. The objective of these efforts should be to develop a broad base of knowledge, skills, and experience in incident management techniques.

   The Federal Highway Administration may wish to consider the following research topics for priority attention:

   - Quick-clearance policies and performance guidelines for incident management, especially with regard to hazardous materials.

- Communications and information management technologies for the collection and dissemination of incident and traffic information to incident management teams and motorists.

- Market research and marketing techniques for the dissemination of incident and traffic information.

- Diversion and contingency plans, and techniques for their distribution to field units to improve teamwork and reduce clearance time.

- Service patrols as an incident management tool and as a means of building a public constituency to support incident management.

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Chapter 1

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10 "Beyond Gridlock: The Future of Mobility as the Public Sees It." Advisory Committee on Highway Policy, 2020 Transportation Program, Washington DC, June 1988.

11 "Intelligent Vehicles and Highway Systems: 1990 Summary." Mobility 2000, July 1990.

12 "Quantification of Urban Freeway Congestion and Analysis of Remedial Measures." Jeffrey A. Lindley, Federal Highway Administration Staff Report RD-87/052, October 1986. See also by the same author "Urban Freeway Congestion: Quantification of the Problem and Effectiveness of Potential Solutions." ITE Journal, January 1987; and "Urban Freeway Congestion Problems and Solutions: An Update." ITE Journal, December 1989. Lindley's estimates are based on HPMS data for freeways in urban areas with populations greater than 50,000. Delay is calculated by comparing the time for travel under congested travel to the time for travel under uncongested conditions. The analysis uses an average travel speed of 55 miles per hour on freeways to represent travel under uncongested conditions. The 1984 cost estimates assume an average vehicle occupancy of 1.25 persons; an average value of travel time of $6.25 per vehicle hour; and a $1.00 per gallon cost of fuel. The 1987 estimates use an average value of travel time of $6.85 per vehicle hour and a $1 .lO per gallon cost of fuel.

Chapter 2

1 Cambridge Systematics, Inc. estimate based on case study interviews with incident management program officials.

2 Cambridge Systematics, Inc. estimate based on case study interviews, incident management program records, and available studies. Few rigorous studies are available; among the best is "Incident Characteristics, Frequency, and Duration on a High Volume Urban Freeway [I-10, Los Angeles]." Genevieve Giuliano, Institute of Transportation Studies, University of California at Irvine, June 1988. (Reprinted May 1989.)

3 JHK & Associates estimate based on delay evaluation procedures in "Alternative Surveillance Concepts and Methods for Freeway Incident Management: Volume Z-Planning and Trade-Off Analyses for Low-Cost Alternatives." Federal Highway Administration, Washington DC, March 1978; "A Freeway Management Handbook: Volume Z-Planning and Design." Federal Highway Administration, Washington DC, May 1983; and modifications recommended by California Department of Transportation engineers interviewed for the case studies.

4 For a review of the impacts of major accidents, see "An Analysis of the Characteristics and Congestion Impacts of Truck-Involved Freeway Accidents." Final Report prepared for the California Department of Transportation by Wilfred W. Recker and others, Institute of Transportation Studies, University of California at Irvine, December 1988.

5 Cambridge Systematics, Inc. based on similar diagrams appearing in "Freeway Incident Management: NCHRP Synthesis of Highway Practice." prepared by David H. Roper for the Transportation Research Board, Washington DC, December 1988; and "A Freeway Management Handbook: Volume -Planning and Design." Federal Highway Administration, Washington DC, May 1983.

6 "Influence of Incidents on Freeway Quality of Service." Merrell E. Goolsby, Highway Research Record 349, Highway Research Board, Washington DC, 1971.

7 "Incident Management Programs in the United States." James R. Robinson and Jonathan D. McDade, Office of Traffic Operations, Federal Highway Administration, Washington DC, October 1990.

8 "Freeway Incident Management." Dennis C. Judycki and James R. Robinson, Office of Traffic Operations, Federal Highway Administration, Washington DC, March 1988.

Appendix A

Chicago Benefit-Cost Analysis

Summary

A benefit-cost analysis of the Chicago incident management program found that the Minuteman program returns $17 in benefits for each $1 invested in the program. The total cost of the program is estimated at $5.5 million per year. The program saves Chicago motorists 9.5 million vehicle-hours of delay valued at $95 million dollars per year. This memorandum describes the methodology and findings of the analysis.

Methodology

Costs for the Chicago program are defined as

Capital (vehicles and garage)
Operations and maintenance (vehicles and garage)
Labor (salaries and fringes)
plus Overhead (Illinois DOT)
Total program costs

Benefits of the Chicago program are defined as

Cost of time delay without the program
less Cost of time delay with a program
Net value of time savings (or loss) to motorists

All benefits and costs are stated in current (1989) dollars. To account for the cost impacts of capital equipment replacement, costs and benefits of the Chicago program are projected forward 15 years and then discounted at rate of 8 percent to calculate net present cost and net present benefit.

The benefit to cost ratio is calculated as

$$\frac{\text{Net present benefit}}{\text{Net present cost}}$$

1989 Budget for Chicago Incident Management Program

Exhibit A-l shows the 1989 line item budget for the Chicago incident management program. The budget totals $3,500,000. Labor costs are the single largest item in the budget, accounting for $2,400,000 or 70 percent of the budget. In 1989 (and early 1990 when the case study was conducted) the Chicago program employed 54 drivers, 9 supervisors, and 12 support staff.

The program operates 35 large tow trucks – emergency patrol vehicles (EPVs). Patrols are fielded 24-hours a day, seven days a week. The EPVs are in operation between 8 and 16 hours a day. They last about four years in regular service. Eight EPV chassis (frame, motor, transmission, axles, and wheels) are replaced each year at a cost of about $30,000 per chassis. (The cabs, tow equipment, and tool boxes are salvaged from the old trucks, refurbished, and remounted on the new chassis.) Fuel and oil cost $4,900 per vehicle per year; and maintenance totals about $6,000 per vehicle per year.

In addition to its EPVs, the Chicago program operates four heavy wreckers. These have an estimated service life of 15 years. Replacement costs are estimated at $220,000 per vehicle. The wreckers see intermittent but intense use; because of this total fuel costs are low, about $4,000 per year. Maintenance costs about $13,000 annually.

The Chicago program is housed in an old industrial garage on property owned by the Illinois Department of Transportation (IDOT). The program pays no rent for the building or land. Total building costs (primarily maintenance) are estimated at $50,000 per year.

The Chicago incident management program must purchase sand (for absorbing oil spills), deicing salt, and other expendable items that are used in incident clearance operations. The 1989 budget allocated $350,000 for these costs.

The line item budget does not include any allowance for general overhead, such as IDOT management, insurance, pension management, or legal services.

Estimated Cost of Chicago Incident Management Program

Exhibit A-2 shows the estimated total cost of the Chicago incident management program. This cost – $5,550,000 per year – was used in the benefit-cost analysis and includes the following adjustments and additions to the 1989 line item budget.

Personnel and EPV costs were increased to reflect the cost of a 36-vehicle fleet. The Chicago program is authorized at 36 vehicles; however, during 1989 the program operated with 35 vehicles.

Building costs totaling $803,300 were added to the budget to reflect the estimated cost of space for the program. The Chicago program is constructing a new $5,000,000 garage with space for maintenance and staff offices. This cost was used as the basis for estimating building costs. Maintenance, heat, light, and cleaning costs for the new building were estimated using current costs for comparable industrial space in Chicago.

General overhead costs totaling $1,186,000 were added to reflect the cost of the management, financial, legal, and pension services, etc., provided by TDOT. These costs were estimated to be equivalent to 48 percent of labor costs.[1]

For comparative purposes, an estimate was made of the cost of operating the Chicago incident management program if vehicles, fuel, and other expendable items were purchased on the commercial market rather than through IDOT. As a public agency that buys in bulk, IDOT obtains discounts of 25 to 50 percent on vehicles, fuel and other supplies. It is estimated that this saves the program about $1.2 million per year. Exhibit A-3 shows the estimated cost of the program assuming that these supplies were purchased without the public sector discounts.

Benefits

Benefits were estimated by determining 1) the number and type of incidents handled annually by the Chicago Minuteman program; 2) the duration of these incidents with and without the program; 3) the likely congestion impacts of the incidents; and 4) the value of the time lost (or saved) in incident congestion. The following sections describe how each of these estimates were determined.

1/ Cambridge Systematics based on conversations with Illinois DOT administrative officers.

Number and Type of Incidents

In 1988 the Chicago Minuteman program responded to 98,300 incidents.' Exhibit A-4 shows the distribution of these incidents by type. Vehicle disablements – mechanical and electrical breakdown, flat tires, and vehicles out of fuel – account for the majority of all recorded assists. Accidents account for only 10 percent of all recorded assists.

It is estimated that 15 percent of the incidents resulted in a vehicle blocking one or more lanes of the expressway. Of these it is estimated that 94 percent block a single lane, and the remaining 6 percent block two or more lanes. These distributions are based on estimates made by Chicago program managers and incident data reported by FHWA[3] and Recker.[4]

All incidents that do not involve a collision, roll-over, jackknife, spill, or lost load were considered shoulder incidents. Eighty-five percent of incidents result in a vehicle on the shoulder of the expressway.

Duration of Incidents

Exhibit A-5 presents the estimated durations of lane-blocking and shoulder incidents. Estimates are made for duration with and without incident management. Typical incident durations are estimated for three scenarios: 1) Full incident management program, defined as service patrols (i.e., Chicago Minutemen) and major incident clearance teams (i.e., Chicago heavy wreckers; Los Angeles major incident response team); 2) Partial incident management program, defined as major clearance teams only (i.e., Chicago heavy wreckers; Los Angeles major incident response team); and 3) No incident management program.

2/ "1988 Chicago Area Expressway Accidents – Annual Summary." Illinois Department of Transportation, Division of Traffic Safety, 1989. The 1988 statistics show 102,931 assists, but 4,636 of these involve the dispatch of a second emergency patrol vehicle to assist units already at the scene of an incident. These second calls were removed to avoid double counting of incidents.

3/ "A Freeway Management Handbook: Volume 2 – Planning and Design." Federal Highway Administration, Washington DC, May 1983.

4/ For an analysis of the frequency, duration, and delay impacts of major truck-involved accidents, see "An Analysis of the Characteristics and Congestion Impacts of Truck-Involved Freeway Accidents." Wilfred W. Recker and others, Institute of Transportation Studies, University of California at Irvine, (Draft Final Report) December 1988.

The estimated incident durations are based on discussions with Chicago and Los Angeles program managers; review of major incidents in Chicago and Los Angeles (Exhibits A-10 through A-20); review of the preliminary results of the Los Angeles Freeway Service Patrol Project; and incident durations reported in the literature by Giuliano,[5] and Recker. The Los Angeles Freeway Service Patrol Project, a test project conducted by the California Highway Patrol in 1988, indicates that shoulder incidents were removed from the freeway ten minutes faster with a service patrol than without a service patrol.

Congestion Impact of Incidents

The congestion delay impacts of freeway incidents were estimated using calculation routines developed by the Federal Highway Administration. These were modified to account for demand reduction. The modifications were based on an analysis of major incidents in Chicago and Los Angeles (Exhibits A-10 through A-20).

Incident Delay Curves

The congestion delay impacts of freeway incidents were estimated using calculation routines developed by the Federal Highway Administration and reported in "Alternative Surveillance Concepts and Methods for Freeway Incident Management: Volume 2 – Planning and Trade-Off Analyses for Low-Cost Alternatives." Federal Highway Administration, Washington DC, March 1978 and "A Freeway Management Handbook: Volume 2 – Planning and Design." Federal Highway Administration, Washington DC, May 1983. The delay estimates were developed as a set of incident delay curves where the delay – measured in vehicle-hours of delay to motorists in the incident queue – is a function of the duration of the incident, the number of freeway lanes, freeway capacity (vphpl), typical peak and off-peak flow rates, and typical incident flow rates. The incident delay curves are shown in Exhibits A-6, A-7 and A-8.

Demand Reduction Modifications

The incident flow rates shown in Exhibits A-6, A-7 and A-8 account for demand reduction. Both Chicago and Los Angeles have well-developed traffic advisory services. When an incident occurs, especially a major

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5/ "Incident Characteristics, Frequency, and Duration on a High Volume Urban Freeway [I-10 Los Angeles]." Genevieve Giuliano, Institute of Transportation Studies, University of California at Irvine, June 1988. (Reprinted May 1989.)

incident, it is widely, and usually accurately, reported. This information makes it possible for drivers to delay their trips or divert to alternate routes.

It is estimated that demand reduction begins within 15 to 30 minutes of the onset of a major incident. Depending upon the severity and duration of the incident, up to 60 percent of normal traffic demand may be diverted. It is further estimated that half of this shift is accounted for by drivers that leave the freeway and seek an alternate route; the other half by drivers that delay their trip or seek an alternative route without ever entering the freeway. To account for this phenomenon, traffic flow rates during an incident were reduced after the first 15 minutes of an incident. For every additional 15-minutes that the incident lasted, demand was reduced by an additional 5 percent. A maximum demand reduction of 40 percent is reflected in the delay curves shown in Exhibits A-6, A-7 and A-8.[6]

Analysis of Major Incidents in Chicago and Los Angeles

As a part of the case studies in Chicago and Los Angeles, a dozen major incidents were analyzed in detail. The objectives the analysis were to: 1) provide a framework for detailed discussion of the management and operations of the programs; 2) examine the impact of the incident management program on incident duration; and 3) develop empirical data on demand reduction and its impact on total delay.

Incident records from the last six months of 1989 were obtained from IDOT and Caltrans. The records were screened to identify incidents that occurred on weekdays between 5 AM and 7 PM; during or shortly before the peak commute periods; on freeway segments equipped with automatic traffic counters; and on freeways that were not under construction. Twenty-five candidate incidents were selected for further review. As a general rule, only common freeway incidents – collisions, jackknifes, lost loads or spills -were considered; unique events were not selected for analysis.

Historical traffic flow data were then obtained from IDOT and Caltrans. These data included mainline traffic flow rates on the day of the incident and one week before and after the incident; and average mainline speeds before, during, and after the incident. If sufficient reliable data were not available, another incident was selected.

Eleven incidents were eventually selected for detailed study. These included five incidents in Chicago and six incidents in Los Angeles. Using the traffic

6/ JHK & Associates based on trends observed by Caltrans engineers performing incident analysis in Los Angeles.

flow and incident response records, traffic flow plots were prepared for each incident.[7] Exhibit A-9 is a summary table describing the duration and impact of each of the incidents. The plots are shown in Exhibits A-10 through A-20. The vehicle-hours of delay that accrue to motorists in the incident queue are represented in the exhibits by the shaded area that lies between the normal flow rate and the lower incident flow rates.[8]

Value of Time

The value of time lost (or saved) by drivers affected by freeway incidents in Chicago was estimated at $10 per hour. This value is a weighted average of the values of time assigned to automobile drivers and truck drivers. According to the Bureau of Labor Statistics, the 1989 average wage rate for the Chicago area was $9.63/hour (without overhead)? The value of time for automobile drivers was estimated to be 80 percent of the average wage rate or $7.70 per hour. The average wage rate for truck drivers in Chicago was estimated to be $20.62 (with benefits).[10] To obtain a weighted average, it was assumed that 80 percent of vehicle-hours of travel on Chicago expressways

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7/ Traffic flow plots and delay calculations are based on models provided in "A Freeway Management Handbook: Volume 2 – Planning and Design." Federal Highway Administration, Washington DC, May 1983.

8/ The level of detail of each plot depends upon the traffic and incident response data available. Less detail was available on the Chicago incidents since the traffic volume data consisted of hourly counts. However, more data on incident response activities was available from Chicago. The Los Angeles incidents are based, in part, on the result of previous incident analyses performed by Caltrans District 7 engineers.

9/ Bureau of Labor Statistics, Employment and Earnings, 1989. The average fully loaded wage rate for all workers in Chicago in 1989 was $12.52, which included a 30 percent allowance for fringe benefits. The reported average wage rate of $9.63 is an adjusted rate reflecting part-time and partial employment during the year.

10/ Bureau of Labor Statistics1988 Area Wage Survey. The mean earning for all truck drivers in Chicago in 1988 was $14.66 per hour (flat rate). Adjusting this to 1989 results in a rate of $14.73 per hour. A fully loaded truck driver wage rate of $20.62 includes a 40 percent fringe. The 40 percent fringe rate reflects an above average benefit rate, similar to that for strong union industries (like steel). Health benefits account for approximately 10 percent of the fringe rate; vacation benefits for 15 percent; unemployment, workers compensation, and other benefits for 5 to 15 percent. The 30 percent fringe for "all workers" reflects both a lower fringe rate and part-time coverage. National average wages for truck drivers are 87 percent of those in Chicago.

was accounted for by automobile drivers (i.e., commuters) and 20 percent by truck drivers and other commercial drivers. The calculated average of $10.68 was rounded downward to a more conservative $10.00 per hour.

Calculation of Benefits

Data Inputs

Exhibit A-21 summarizes the data and assumptions used to estimate the hours and cost of delay for incidents on the Chicago expressways. Three scenarios were estimated: 1) Full incident management program, defined as service patrols (i.e., Chicago Minutemen) and major incident clearance teams (i.e., Chicago heavy wreckers); 2) Partial incident management program, defined as major clearance teams only (i.e., Chicago heavy wreckers); and 3) No incident management program.

The number of incidents (line 1) are those responded to by the Minutemen in 1988. The program saw a modest increase in the number of assists in 1989, however, the tabulations for 1989 were not available in time for the case study analysis. The analysis does not include incidents responded to by the Illinois State Police only, and therefore understates the total number of incidents on the expressway system. (The State Police log accidents and other incidents, but tabulate and report only accidents.)

The percentages of lane-blocking and shoulder incidents (lines 2 and 3) are based on the distribution of 1988 incidents. A brief review of incident assist tabulations from prior years suggests that these proportions remain relatively stable from year to year, but no detailed analysis was done to determine the likely variation. The distributions are similar to those reported by incident program managers in other cities.

The distribution of incidents by time of day (line 4) was assumed to be proportional to traffic volumes by time of day: 40 percent during the morning and evening peak periods; another 40 percent during the midday off-peak; and the remaining 20 percent during the late night or early morning hours.[11] Only incidents occurring during the peak and midday periods – and therefore creating significant congestion -were considered for this analysis.

The number of expressway lanes (line 5) was developed from IDOT statistics for the Chicago district.

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11 / This distribution is in accord with incident data reported in the literature by Ziesler, Vallette, Najjar, and NASS.

Typical incident durations (line 6) for each scenario are the same as those shown in Exhibit A-5. The vehicle-hours of delay by type of incident (line 7) were derived from the incident delay curves (Exhibits A-6, A-7 and A-8) and account for demand reduction.

Delay cost was approximated by using a weighted value of time of $10 per hour.

Delay Estimates

Exhibit A-22 summarizes the vehicle-hours of delay and delay costs for each of the scenarios. The analysis shows that:

- Scenario 1: Full Program (service patrols and major incident response teams) results in 11.6 million vehicle hours of delay at a cost of $116.6 million to Chicago area automobile and truck drivers. This represents a savings of 9.5 million vehicle hours of delay and $95 million when compared to the worst case, Scenario 3-No Program.

- Scenario 2: Partial Program (major incident response teams only) results in 15.5 million vehicle hours of delay at a cost of $154.7 million to motorists. This represents a savings of 5.6 million vehicle hours and $56 million over Scenario 3.

- Scenario 3: No Program results in 21 million vehicle hours of delay at a cost of $211 million.

The analysis understates the impact of incident delays by disregarding the value of time for automobile passengers. An average auto occupancy of factor of 1.2 would increase person-hours of delay by 20 percent, although the value of this additional time is often heavily discounted. The analysis also does not account for fuel wasted (or saved). The fuel costs of incident congestion have been variously estimated to be about one gallon per vehicle-hour of delay. At a cost of one dollar per gallon, inclusion of this cost would add about a dollar per vehicle hour of delay. A third factor not estimated for this analysis is the opportunity cost of time delays to shippers and receivers whose goods are delayed in transit. Finally, no estimate was made of the delay costs (or savings) accruing to motorists who, upon hearing about an incident, delayed their trips or took alternative routes. Caltrans has done some empirical research on travel times for incident diversion routes, and researchers have used network models to explore the impact of information on travel time, but no attempt was made to quantify this effect in this case study.

The incidence of the costs and benefits are very different. The costs of the Chicago incident management program, which are very tangible costs, are borne by Illinois **DOT. The** benefits, which are much less tangible, accrue to motorists using the Chicago expressway. The large majority of these, and therefore the major beneficiaries, are Chicago area commuters. Their delay savings directly benefit the Chicago metropolitan economy. Truck drivers, and therefore their employers, are also significant beneficiaries of the delay savings provided by the incident management program. Some of their savings accrue to Chicago area business and industry, but some of the savings benefit business and industry outside the Chicago area. The Chicago incident management program is funded from state motor fuel taxes. In general, urban automobile owners pay a disproportionately large share of motor fuel taxes. To the extent that this is true in Chicago, the benefits of the program may be accruing to those largely responsible for funding it. The analysis did not attempt to prove or disprove this linkage.

Net Present Costs and Benefits

Exhibit A-23 presents the net present costs and benefits and the benefit-cost ratios for each of the scenarios. For comparative purposes, the net present costs and benefits were calculated at discount rates of 8 percent and 5 percent. The analysis of the Chicago incident management program finds that the Minuteman program returns $17 in benefits for each $1 invested in the program.

Exhibit A-l. 1989 Line Item Budget For Chicago Incident Management Program

	Budget
1. Personnel, including fringes (of 35%) (54 drivers, 9 supervisors, 12 support)	$2,400,000
2. EPV's (36 in fleet, 4-yr. use; currently 35)	
Replacement	
Purchase 8 chassis/yr @$30,000	240,000
Operations	
Fuel and Oil ($4,900/vehicle)	171,500
Maintenance, tires, batteries, etc. ($6,067/vehicle)	212,332
3. Heavy Wreckers (4 in service, 15 yr. life)	
Replacement (one every 3.75 yrs.)	
Purchase ($220,000/3.75)	58,677
Operating Costs	
Fuel and Oil	4,328
Maintenance (tires, batteries, etc.)	12,872
4. Annual Building Maintenance Costs	
Estimated 50,000 sq.ft. @$1.00	50,000
5. Other Operating Costs, salt, sand, etc.	350,291
6. General Overhead	-0-
GRAND TOTAL	$3,500,000

Exhibit A-2. Estimated Cost For Chicago Incident Management Program

	Annual cost
1. Personnel, including fringes (of 35%) (54 drivers, 9 supervisors, 12 support)	$2,470,000
2. EPV's (36 in fleet, 4-yr. use)	
Replacement	
Purchase 9 chassis/yr @ $30,000	270,000
Operations	
Fuel and Oil ($4,900/vehicle)	176,400
Maintenance, tires, batteries, etc. ($6,067/vehicle)	218,412
3. Heavy Wreckers (4 in service, 15 yr. life)	
Replacement (one every 3.75 yrs.)	
Purchase ($220,000/3.75)	58,677
Operating Costs	
Fuel and Oil	4,328
Maintenance (tires, batteries, etc.)	12,872
4. Annual Building Maintenance Costs	
New $4,800,000 building, $200,000 land, 60,000 sq. ft. @ $80/ft. construction	
Annual Debt Service @ 8%, 20 yrs.	509,300
Maintenance @ 3% of Building Cost	144,000
Heat, Light, Cleaning @$250/ft.	150,000
5. Other Operating Costs, salt, sand, etc.	350,291
6. General Overhead	
Insurance, Management, cover = 48%	1,185,600
GRAND TOTAL	$5,549,869

Exhibit A-3. Estimated Cost For Chicago Program Without Public Sector Discounts

	Annual cost
1. Personnel, including fringes (of 35%) (54 drivers, 9 supervisors, 12 support)	$2,470,000
2. EPV's (36 in fleet, 4-yr. use)	
Replacement	
Purchase 9 chassis/yr @ $60,000	***540,000***
Operations	
Fuel and Oil ($4,900/vehicle)	220,500
Maintenance, tires, batteries, etc. ($6,067/vehicle)	273,015
3. Heavy Wreckers (4 in service, 15 yr. life)	
Replacement (one every 3.75 yrs.)	
Purchase ($275,000/3.75)	73,333
Operating Costs	
Fuel and Oil	5,410
Maintenance (tires, batteries, etc.)	16,090
4. Annual Building Maintenance Costs	
New $7 Million building, $1 million land (60,000 sq. ft. @$100 construction)	
Annual Debt Service @ ll%, 20 yrs.	879,029
Maintenance @ 3% of Building Cost	180,000
Heat, Light, Cleaning @ $3.13/sq. ft.	187,500
5. Other Operating Costs, salt, sand, etc.	437,864
6. General Overhead	
Insurance, Management, cover = 48%	1,440,000
GRAND TOTAL	***$6,722,741***

Exhibit A-4. Distribution of Incident Assists by Type of Incident

Type	Number (1988)	Percentage
Lane Blocking:		
Accident	9,962	10.1
Debris	5,108	5.2
Total Lane Blocking	15,070	15.3
Non-Lane Blocking (Shoulder):		
Fire	468	0.5
Abandoned	17,843	18.2
Mechanical / Electrical / Fuel	59,654	60.7
Non-Disability	2,293	2.3
Other	2,967	3.0
Total Non-Lane Blocking	83,225	84.7

Exhibit A-5. Typical Incident Durations by Type of Program

Type	Incident Response Teams & Service Patrols		Incident Response Teams Only		No DOT Incident Response	
	Chicago	Los Angeles	Chicago	Los Angeles	Chicago	Los Angeles
Lane Blocking:						
1 Lane	40 min.		50 min.	60 min.	75 min.	75 min.
2+ Lanes	60 min.		70 min.	75 min.	loo min.	100 min.
Shoulder	20 min.		30 min.	30 min.	30 min.	30 min.

Exhibit A-6. Freeway Incident Delay: Two Lanes

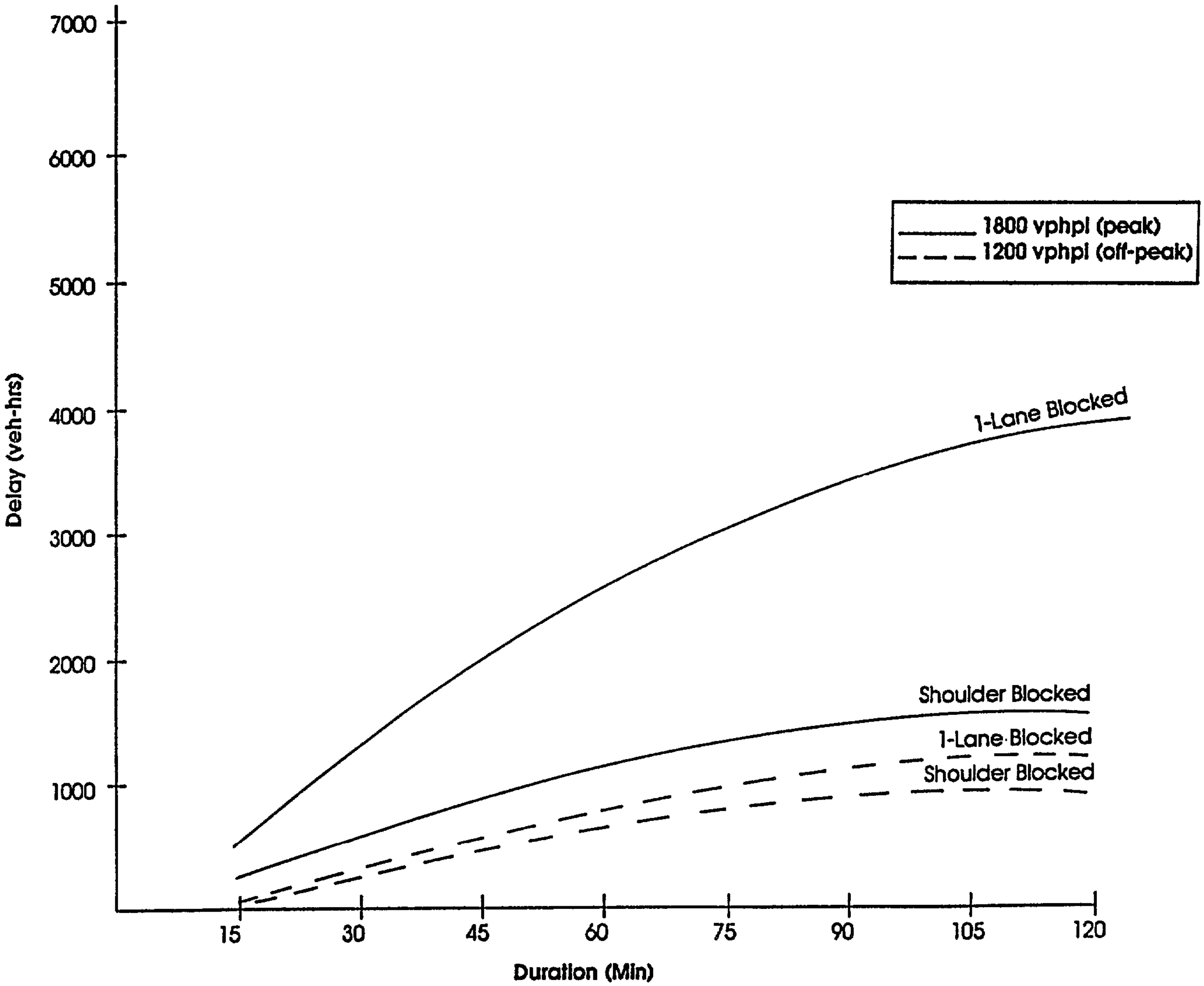

Exhibit A-7. Freeway Incident Delay: Three Lanes

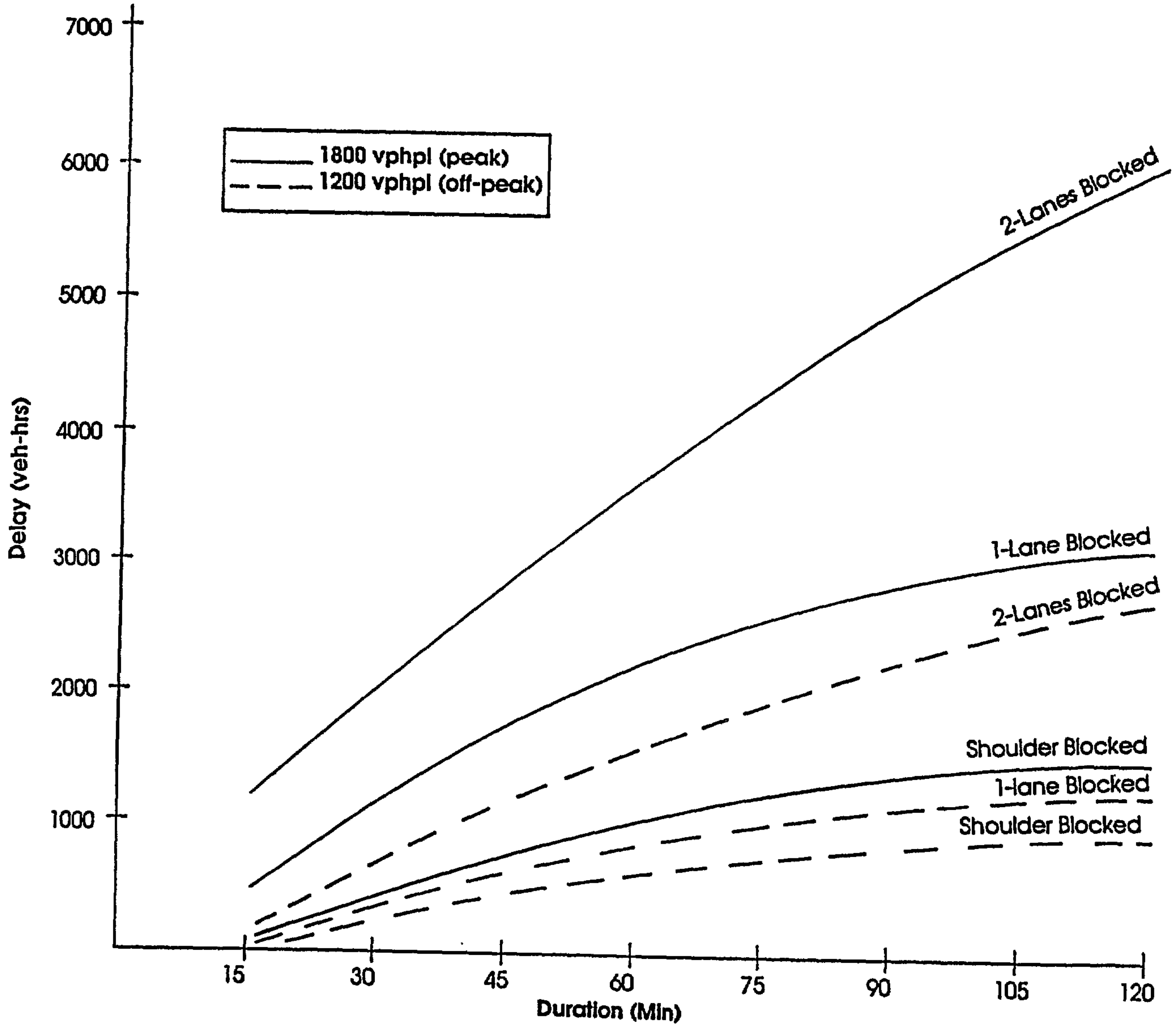

Exhibit A-8. Freeway Incident Delay: Four Lanes

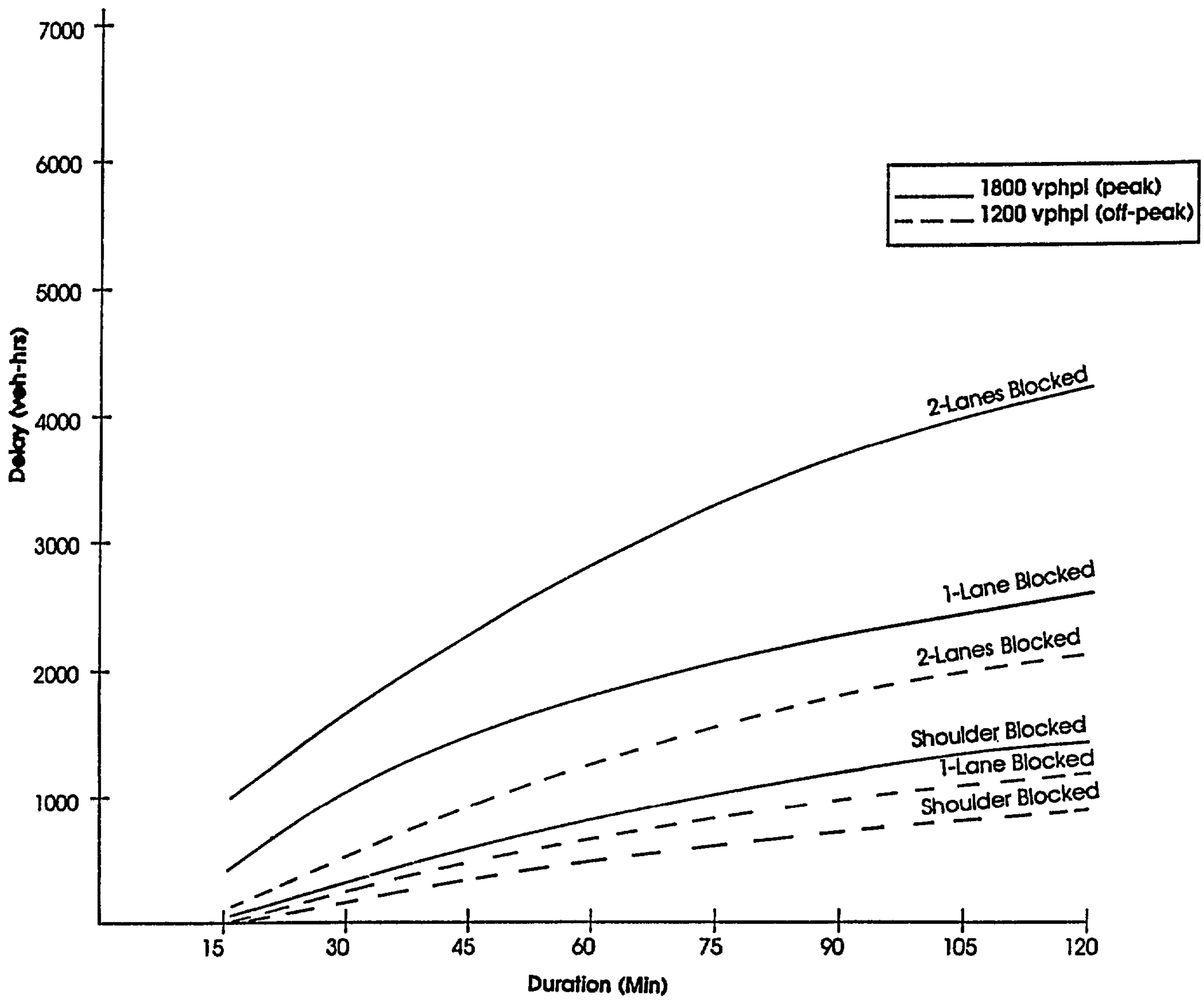

Exhibit A-9. Chicago and Los Angeles Incidents: Duration and Delay Impacts

	Location	Incident	Duration	Impact (Lanes Closed)	Delay (Vehicle-Hours)
Chicago					
1.	EB Eisenhower at Central Ave.	Spill (Diesel)	35 min.	1 lane	2200
2.	WB Eisenhower at Desplains	Lost Load	35 min.	1 lane	3150
3.	SB Dan Ryan at 55th	Lost Load	1 hr. 25 min.	2 lanes	1800
4.	NB I-57 at 167th	Multiple Vehicle Collision	1 hr. 30 min.	1 lane	1250
5.	NB Dan Ryan at 59th	Jack knife	35 min.	2 lanes	800
Los Angeles					
6.	NB I-605 at Alondra Blvd.	Chem. spill	lhr.15 min.	2 lanes	1800
7.	I-5 at Lakewood	Overturned truck	45 min.	2 lanes	945
8.	SB I-710 at Rosencrans Blvd.	Accident	1 hr.40 min.	1 lane	3900
9.	SB I-605 at Spring Street	Overturned truck	1 hr. 40 min.	All lanes	12,600
10.	NB I-101 at Melrose Ave.	Tanker fire	1 hr. 15 min.	l-3 lanes	2100
11.	SB LA 710 near Compton	Jack knife	1 hr. 20 min.	3 lanes	1800

Exhibit A-10. Chicago: Diesel Spill on the Eisenhower

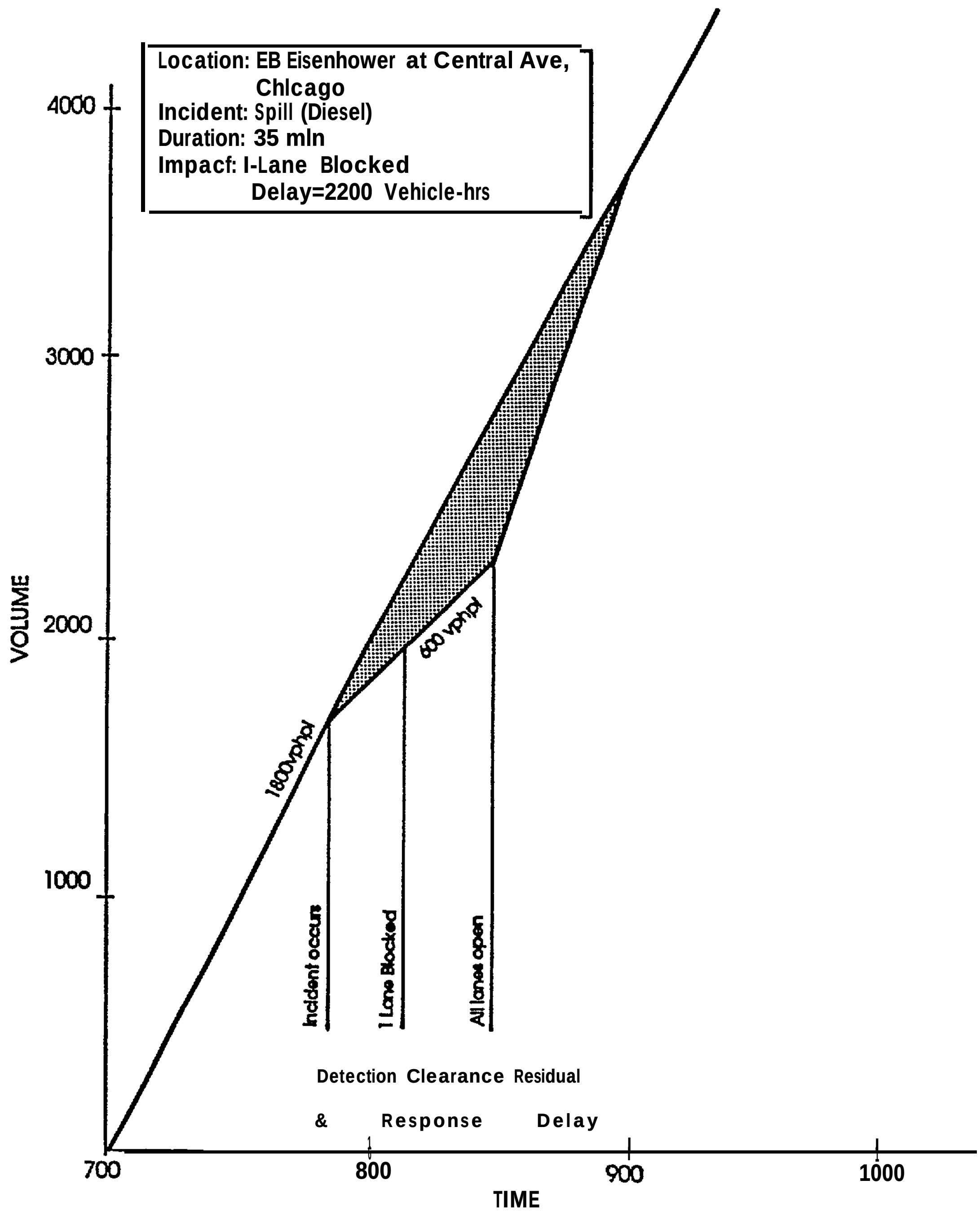

Exhibit A-11. Chicago: Lost Load (Steel Coil) on the Eisenhower

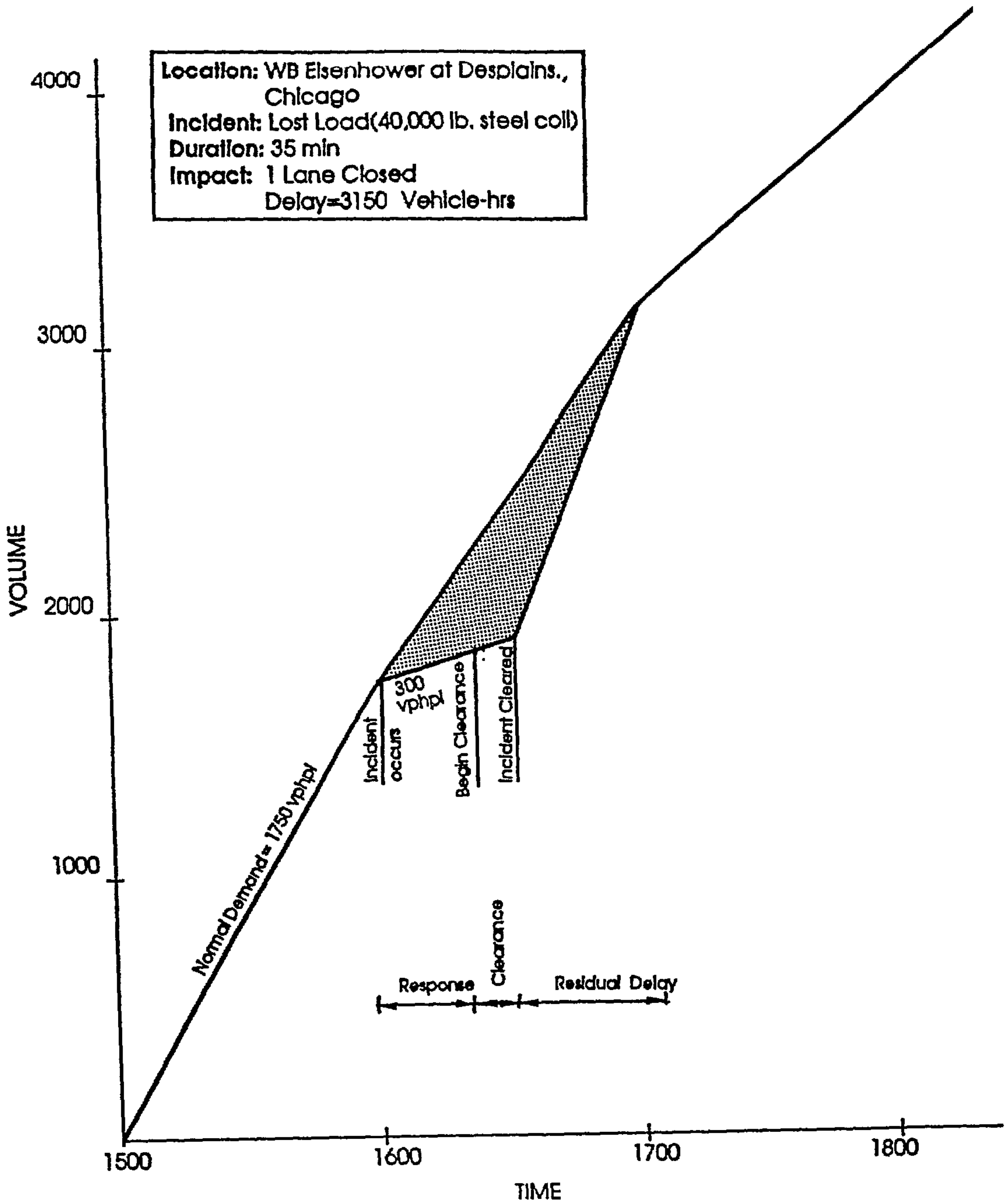

Exhibit A-12. Chicago: Lost Load on the Dan Ryan

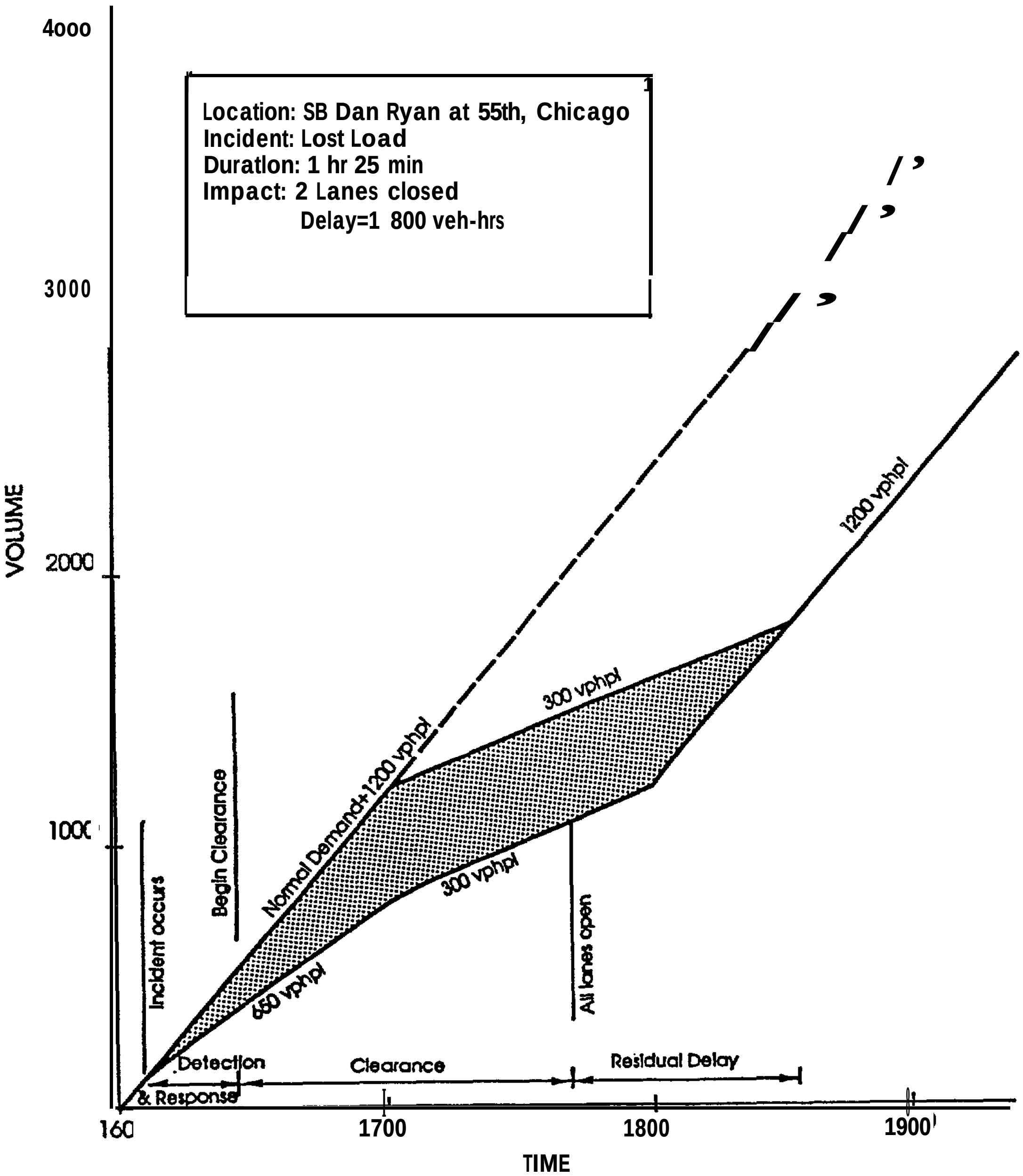

Exhibit A-13. Chicago: Multiple Vehicle Collision on the I-57

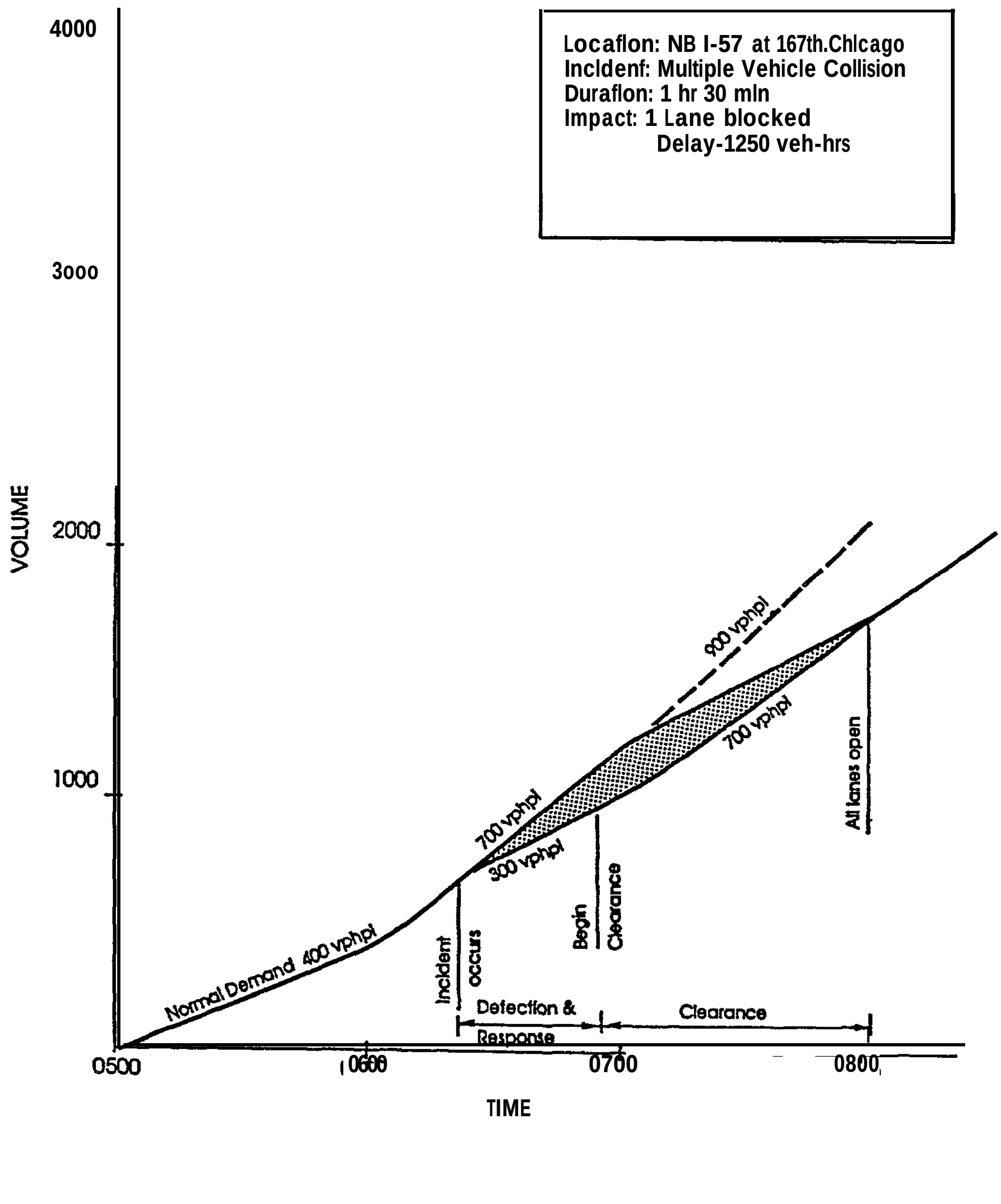

Exhibit A-14. Chicago: Jackknifed Truck on the Dan Ryan

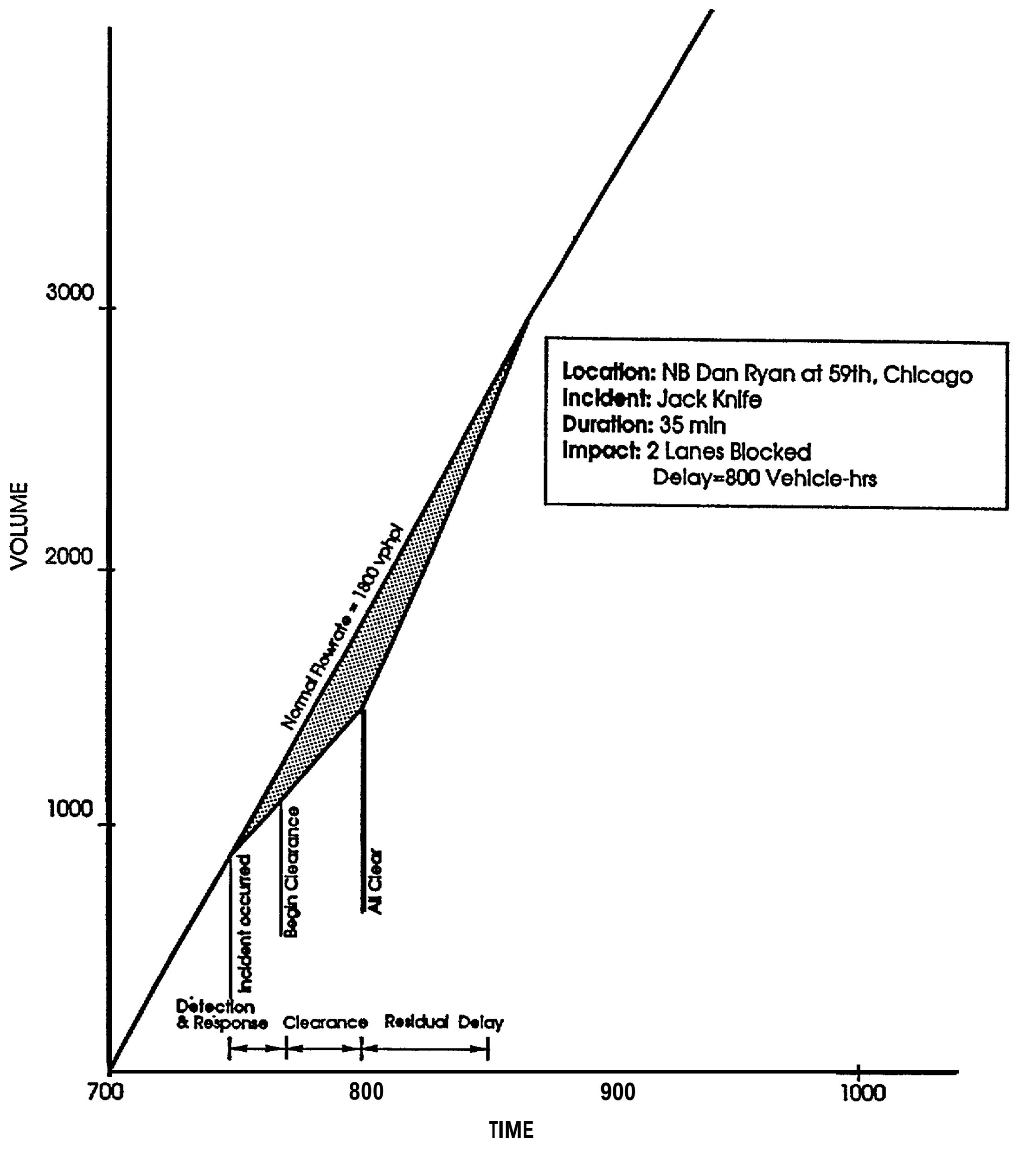

Exhibit A-15. Los Angeles: Chemical Spill on I-605

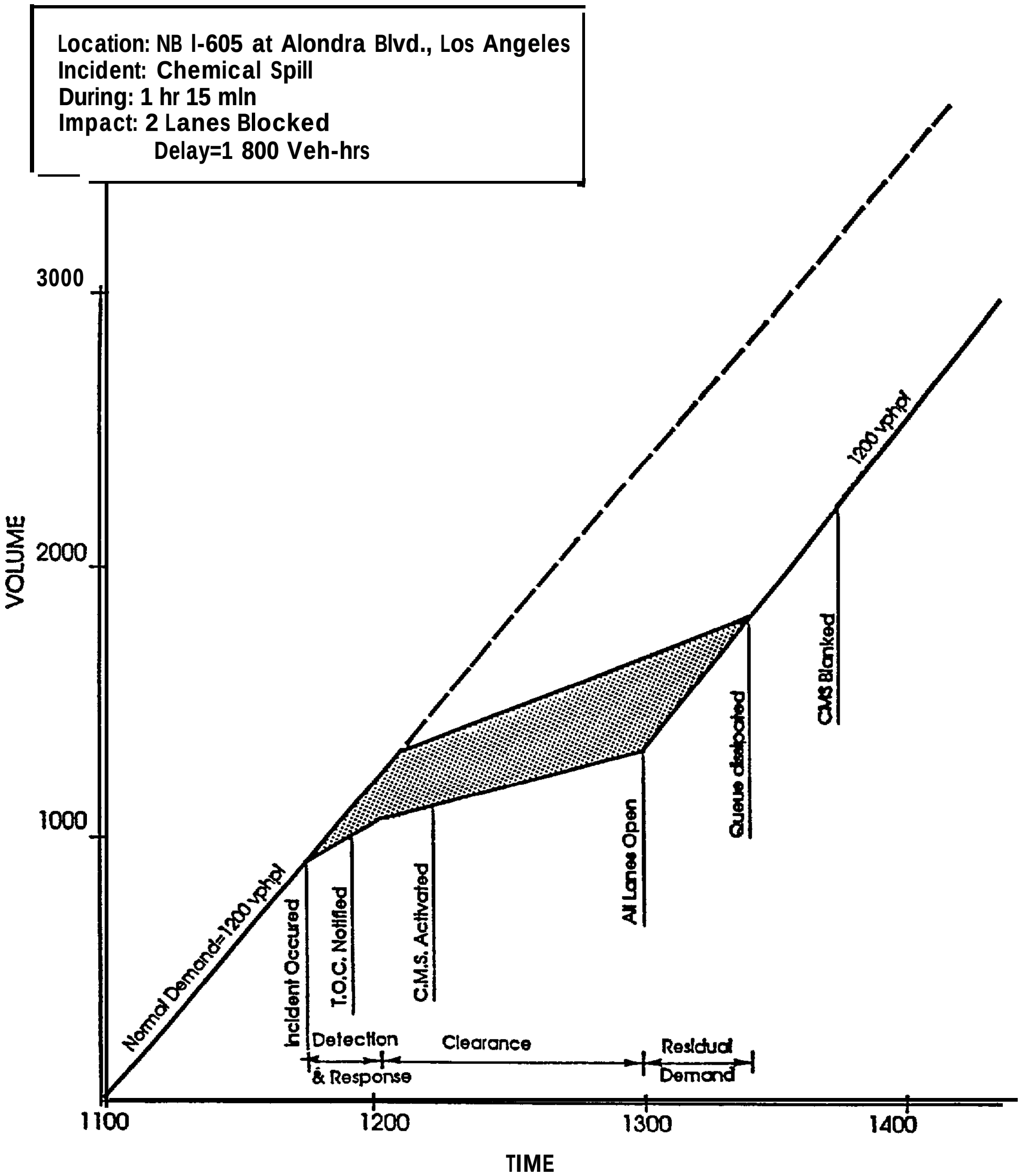

Exhibit A-16. Los Angeles: Overturned Truck on I-5

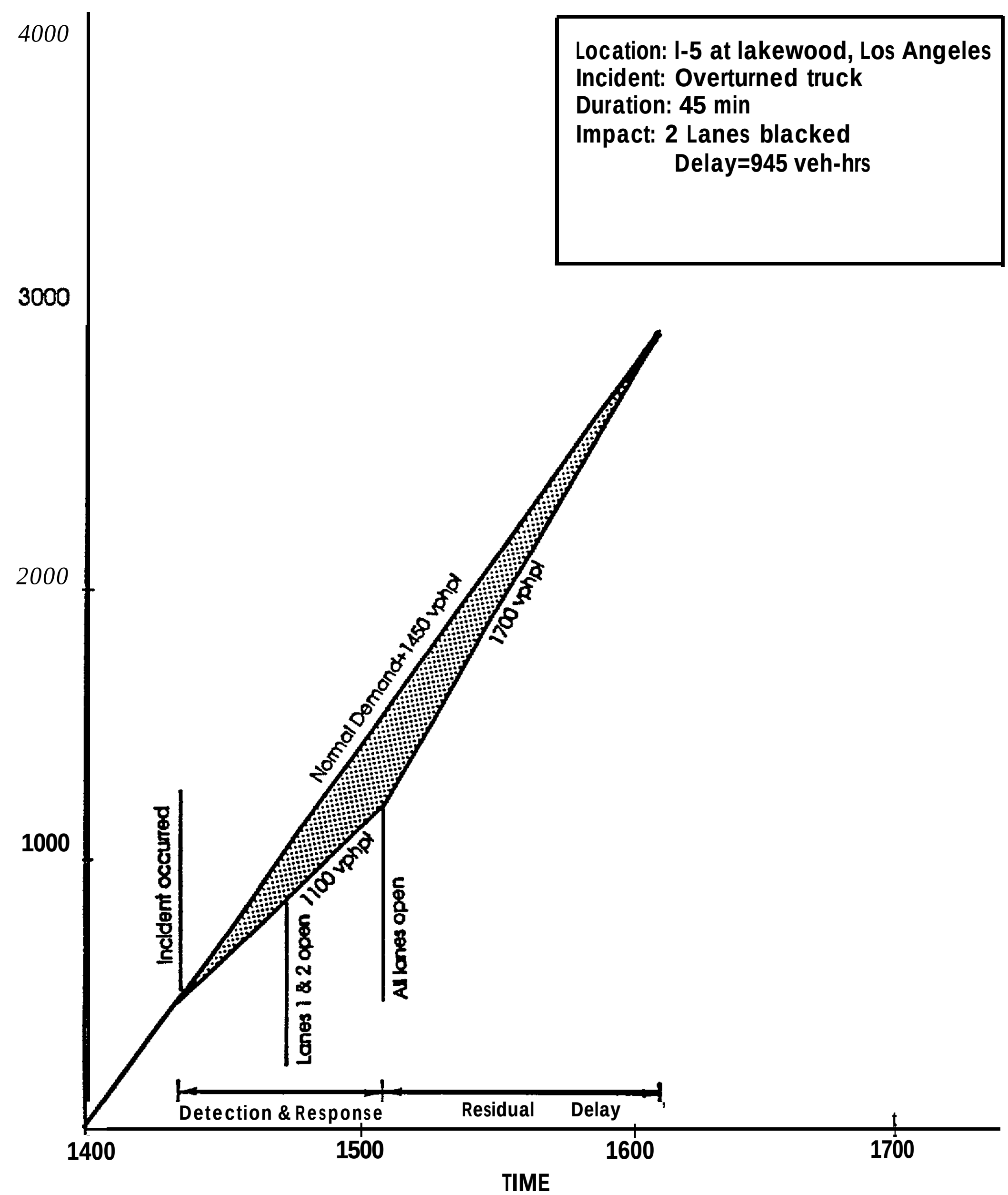

Exhibit A-17. Los Angeles: Accident on I-710

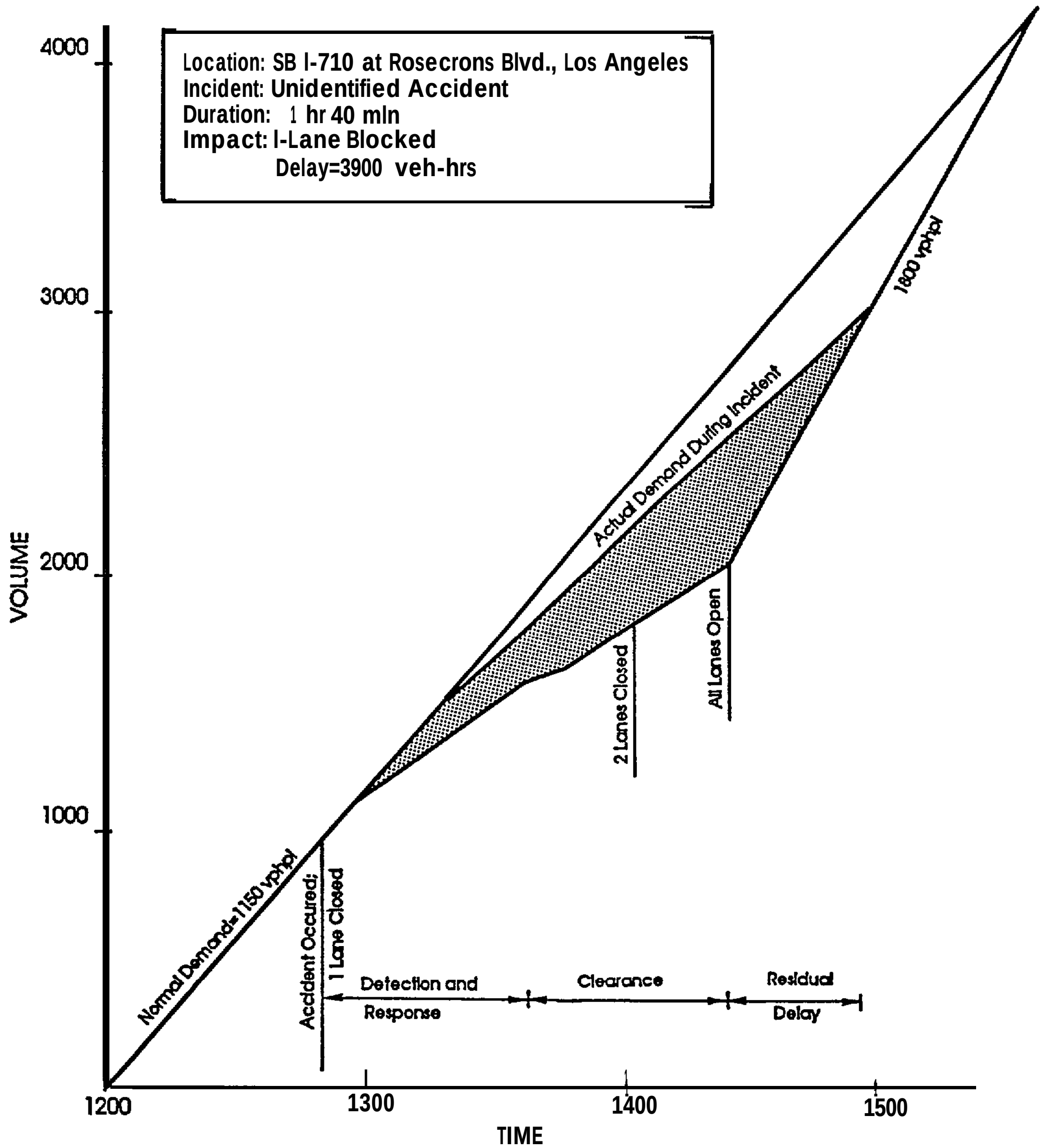

Exhibit A-18. Los Angeles: Overturned Truck on I-605

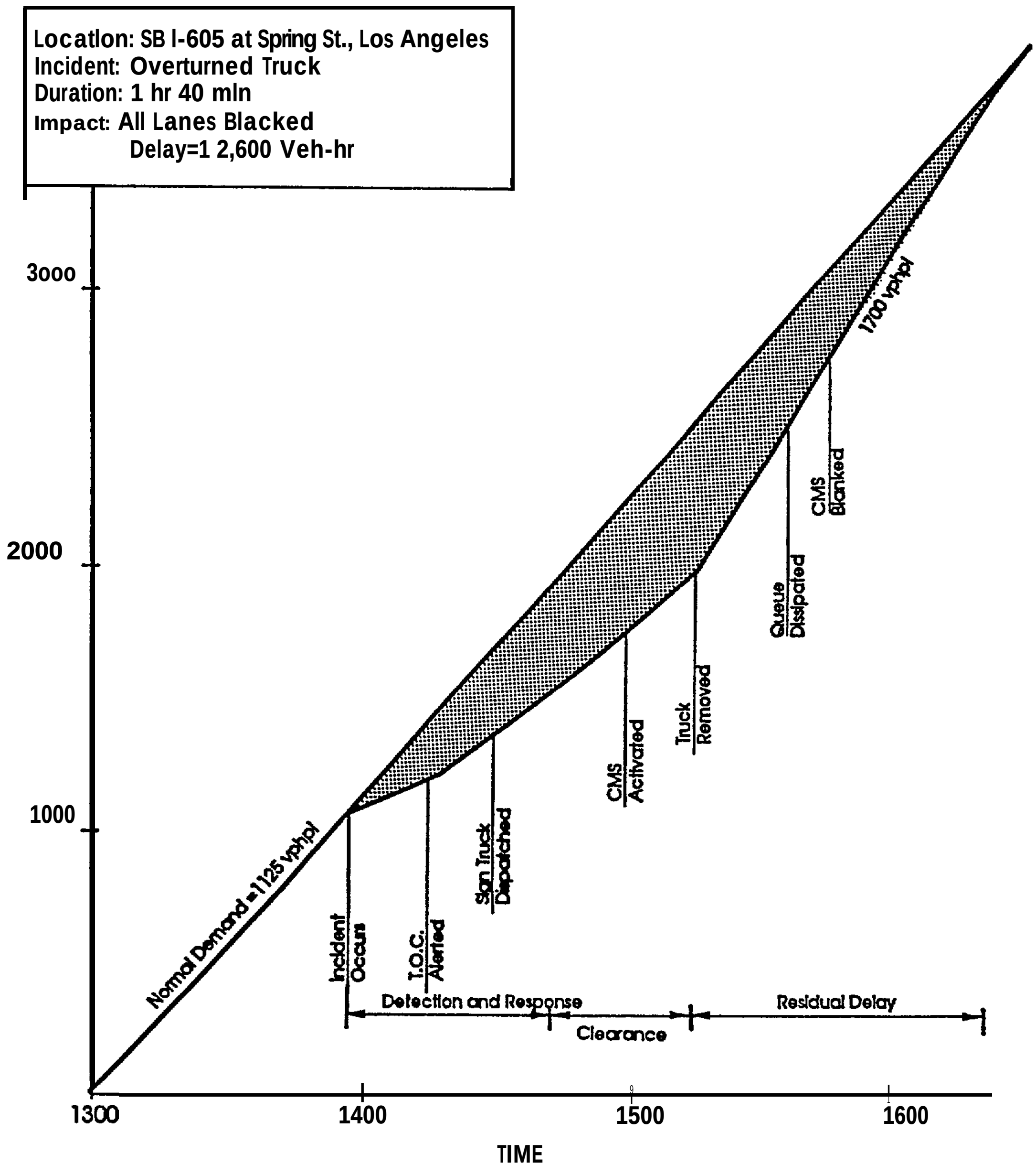

Exhibit A-19. Los Angeles: Tanker Fire on I-101

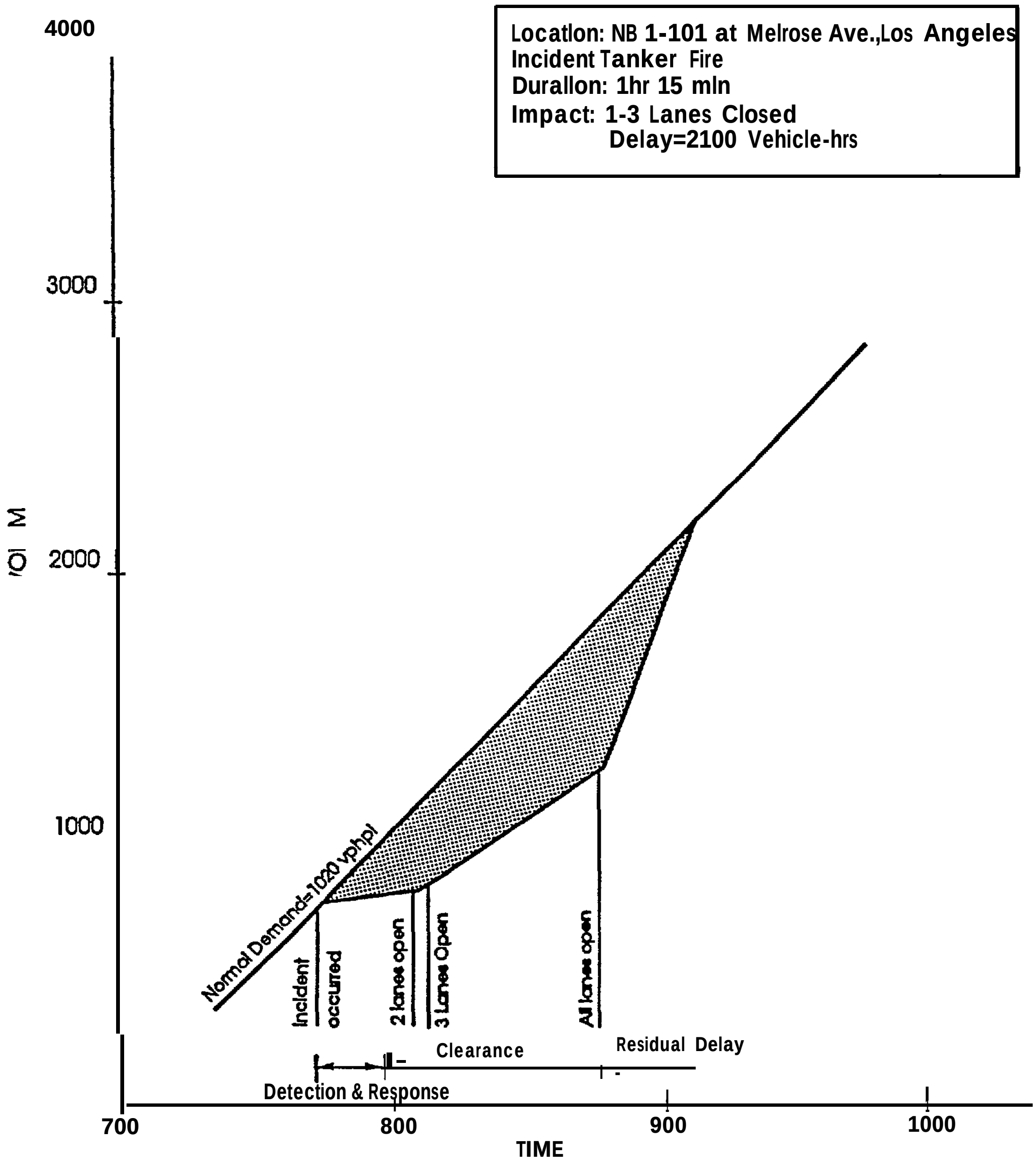

Exhibit A-20. Los Angeles: Jackknifed Truck on 710

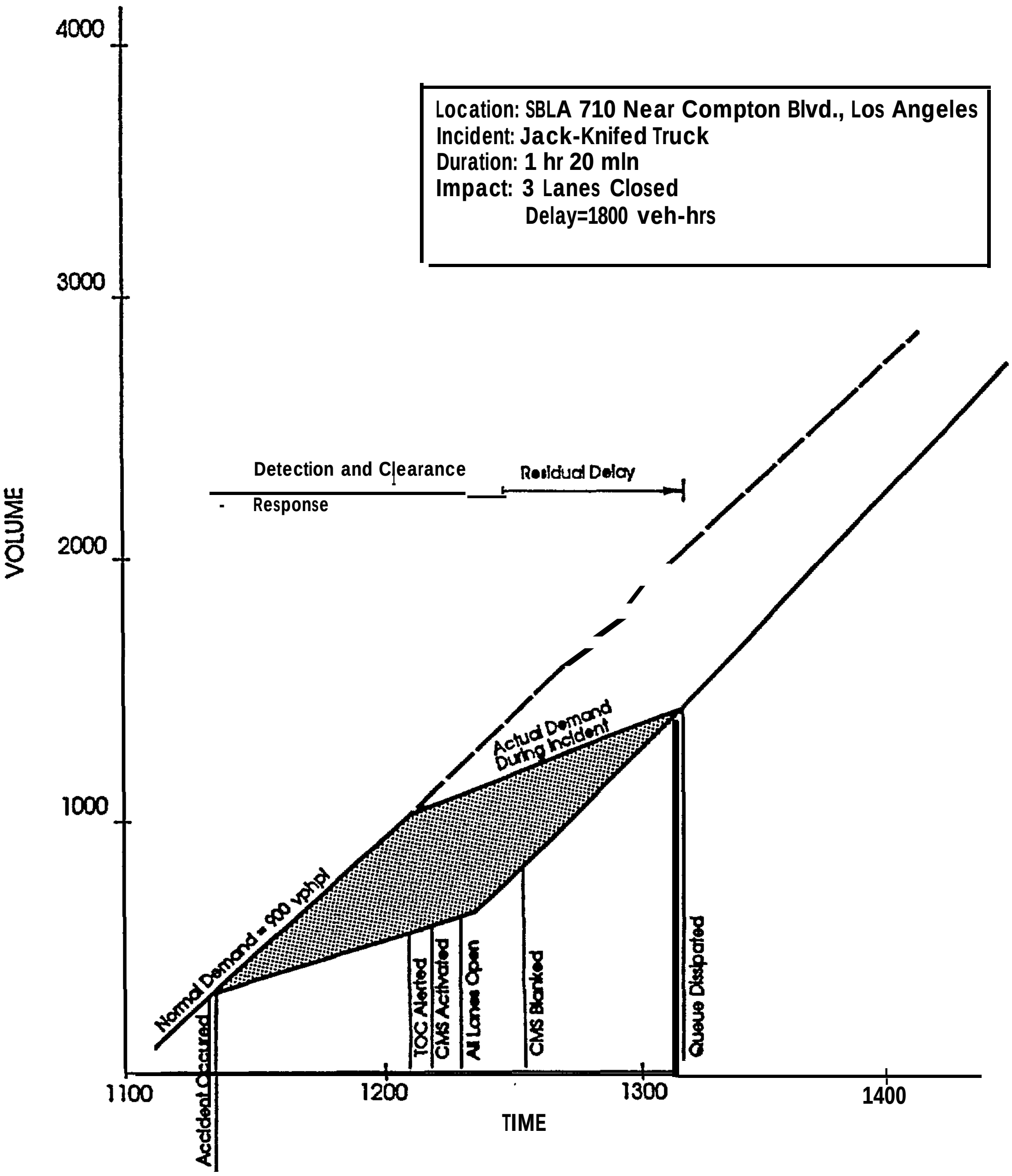

Exhibit A-21. Data and Assumptions for Delay and Benefit Calculations

SCENARIO 1 **Full Program (Service Patrols and Major Incident Response Teams)**		**SCENARIO 2** **Partial Program (Major Incident Response Teams Only)**		**SCENARIO 3** **No Program**	
1) Total Number of Incidents :	98295	1) Total Number of Incidents :	98295	1) Total Number of Incidents :	98295
Responded	98295	Responded	98295	Responded	98295
Unresponded	0	Unresponded	0	Unresponded	0
2) Percentage Lane Blocking	15.3	2) Percentage Lane Blocking	15.3	2) Percentage Lane Blocking	15.3
1 Lane	94.0	1 Lane	94.0	1 Lane	94.0
2+ Lanes	6.0	2+ Lanes	6.0	2+ Lanes	6.0
3) Percentage Shoulder Incidents	84.7	3) Percentage Shoulder Incidents	84.7	3) Percentage Shoulder Incidents	84.7
4) Distribution by Time of Day		4) Distribution by Time of Day		4) Distribution by Time of Day	
Peak Periods	40.0	Peak Periods	40.0	Peak Periods	40.0
Off-Peak Period	40.0	Off-Peak Period	40.0	Off-Peak Period	40.0
Night	20.0	Night	20.0	Night	20.0
5) Typical Number of Lanes	3	5) Typical Number of Lanes	3	5) Typical Number of Lanes	3
6) Typical Incident Duration (mm.)		6) Typical Incident Duration (min.)		6) Typical Incident Duration (mm.)	
Lane Blocking		Lane Blocking		Lane Blocking	
1 Lane	40.0	1 Lane	50.0	1 Lane	75.0
2+ Lanes	60.0	2+ Lanes	70.0	2+ Lanes	100.0
Shoulder	20.0	Shoulder	30.0	Shoulder	30.0
7) Typical Incident Delay (veh-hrs)		7) Typical Incident Delay (veh-hrs)		7) Typical Incident Delay (veh-hrs)	
Peak Periods		Peak Periods		Peak Periods	
Lane Blocking		Lane Blocking		Lane Blocking	
1 Lane	1000	1 Lane	1300	1 Lane	1750
2+ Lanes	3000	2+ Lanes	3500	2+ Lanes	5000
Shoulder	100	Shoulder	150	Shoulder	200
Off-Peak Period		Off-Peak Period		Off-Peak Period	
Lane Blocking		Lane Blocking		Lane Blocking	
1 Lane	200	1 Lane	250	1 Lane	350
2+ Lanes	1000	2+ Lanes	1250	2+ Lanes	2000
Shoulder	0	Shoulder	0	Shoulder	0
3) Typical Delay Costs	$10.00	8) Typical Delay Costs	$10.00	8) Typical Delay Costs	$10.00

Exhibit A-22. Delays and Benefits by Incident Management Program Scenario

SCENARIO 1. Full Program (Service Patrol and Major Incident Response Team)

		Peak Period		Off-Peak Period		Annual Total
Incident Type	Delay	cost	Delay	cost	Delay	cost
Lane Blocking						
1 Lane	5,654,715	$56,547.148	1,130,943	$11,309,430	6,785,658	$67,856,580
2+ Lanes	1,082,818	$10,828,177	360,939	$3,609,392	1,443,757	$14,437,570
Shoulder	3,330,235	$33,302,346	0	$0	3,330,235	$33,302,350
Annual Total	10,067,768	$100,677,680	1,491,882	$14,918,820	11,559,650	$115,596,500

SCENARIO 2. Partial Program (Major Incident Response Teams Only)

		Peak Period		Off-Peak Period		Annual Total
Incident Type	Delay	cost	Delay	cost	Delay	cost
Lane Blocking						
1 Lane	7,351,129	$73,511,290	1,413,679	$14,136,790	8,764,808	$87,648,080
2+ Lanes	1,263,287	$12,632,870	451,174	$4,511,740	1,714,461	$17,144,610
Shoulder	4,995,352	$49,953,520	0	$0	4,995,352	$49,953,520
Annual Total	13,609,768	$136,097,680	1,864,853	$18,648,530	15,474,621	$154,746,210

SCENARIO 3. No Program

		Peak Period		Off-Peak Period		Annual Total
Incident Type	Delay	cost	Delay	cost	Delay	cost
Lane Blocking						
1 Lane	9,895,751	$98,957,510	1,979,150	$19,791,500	11,874,901	$118,749,010
2+ Lanes	1,804,696	$18,046,960	721,878	$7,218,780	2,526,574	$25,265,740
Shoulder	6,660,469	$66,604,690	0	$0	6,660,469	$66,604,690
Annual Total	18,360,916	$183,609,160	2,701,028	$27,010,280	21,061,944	$210,619,440

Exhibit A-23. Benefits and Costs of Chicago Incident Management Program

	Annual	Discounted (15 Years) 8%	5%
3. No Incident Management Program			
Total Cost of Delays	$210617,447	$1,802,772,685	$2,186,157,857
2. Partial Incident Management Program			
Benefits (Time Savings) ($210.6 Million - $154.7 Million)	$55,873,237	$478,245,781	$579,945,094
Program Costs			
Personnel	$2,223,000		
EPV (Equip., Maint., Ops.)	$664,812		
Other Costs (Sand, Salt, etc.)	$350,291		
Building (Construction, Maintenance)	$722,970		
Overhead (Insurance, Mgmt, etc.)	$1,067,040		
Subtotal	$5,028,113	$43,038,026	$52,190,094
Net Benefits	$50,845,124	$435,207,755	$527,755,000
Benefit/Cost Ratio	11:1	11:1	11:1
1. Full Incident Management Program			
Benefits (Time Savings) ($210.6 Million - $115.6 Million)	$95,022,956	$813,346,967	$986,305,789
Program Costs			
Personnel	$2,470,000		
EPV (Equip., Maint., Ops.)	$664,812		
Heavy Wreckers (Equip., Maint.)	$75,867		
Other Costs (Sand, Salt, etc.)	$350,291		
Building (Construction, Maintenance)	$803,300		
Overhead (Insurance, Mgmt, etc.)	$1,185,020		
Subtotal	$5,549,290	$49,521,952	$57,257,190
Net Benefits	$89,473,666	$763,825,015	$929,048,599
Benefit/Cost Ratio	17:1	17:1	17:l

Appendix B

Copy

MARYLAND STATE HIGHWAY ADMINISTRATION

MAINTENANCE POLICY 71.0l-05.1- Revised April 23, 1990

SUBJECT: PROMPTLY REOPENING ROADWAY TO TRAFFIC
Road/Lane Blocked/Closed by Accident or Loads Falling from Trucks.

PURPOSE: Whenever a roadway or travel lane is closed or partially blocked by an accident and traffic delays or safety problems may occur, the RME or his representative in cooperation with the police officer in charge should reopen the roadway as soon as possible ON AN URGENT BASIS. This policy recognizes that public safety is the highest priority and must be secured, especially if injuries or hazardous materials are involved. It is understood that damage to vehicles or cargo may occur as a result of clearing the roadway on an urgent basis. While reasonable attempts to avoid such damage should be taken, the highest priority is public safety.

PROCEDURE: Type of Occurrence

GENERAL

The RME or his representative is to assign the necessary equipment and manpower to reopen the road or lane as soon as possible.

If the incident involves any truck (other than a pick-up) or removal of debris (safe spilled cargo), a rubber-tired Front End Loader shall be dispatched to the scene as soon as possible in the event it could be needed to assist a tow truck in righting/relocating the vehicle(s) involved, or assisting in debris removal/relocation.

If commercial help does not arrive within a reasonable period of time, SHA forces shall begin the removal of vehicle(s)/spilled safe cargo.

If the commercial help is unable to correct the situation, the SHA shall assist by using the Front End Loader as needed.

If materials being transported are spilled, the SHA will make every effort to relocate the materials in the shortest possible time, using whatever equipment is necessary. All such materials shall be relocated as short a distance as possible, but not to be placed so as to present a traffic hazard.

The RME or his representative shall prepare a list of the personnel and equipment used and the work hours involved so that the owner of the vehicle and/or cargo can be billed for the cleanup. The SHA's towing response form shall also be completed for every incident involving the SHA.

Appropriate warning devices (signs, barricades, arrowboards, etc.) are to be placed on the scene should either the damaged vehicle(s) or cargo remain adjacent to the shoulder.

HAZARDOUS/FLAMMABLE/EXPLODING MATERIALS

No attempt is to be made by SHA personnel/equipment to remove any hazardous or flammable explosive material for any reason. If the SHA is first on the scene and the cargo content is not readily identifiable, the RME or his representative will contact the proper authorities to ascertain if special measures should be taken.

As soon as the public safety has been secured, then reopening the roadway is to proceed as described under "GENERAL" in this memorandum.

E. William Ensor, Jr.
Deputy Chief Engineer — Maintenance